UNIVERSITY OF NATAL

PIETERMARITZBURG

SOUTH AFRICA

WATTLE RESEARCH INSTITUTE

South African Wattle Growers' Union — University of Natal

Union Department of Forestry

REPORT FOR 1953-1954

(SEVENTH YEAR)

OCTOBER, 1954

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COMMITTEE OF CONTROL OF THE INSTITUTE

Appointed by the South African Wattle Growers' Union (3) :

S. Clegg, Esq. (*Chairman*).

R. B. Fyfe, Esq.

D. R. Scott, Esq.

Appointed by the University of Natal (2) :

Professor A. J. W. Bayer, D.Sc. (*Vice-Chairman*).

Principal E. G. Malherbe, M.A., Ph.D., LL.D.

Alternate : Professor A. R. Saunders, D.Sc.Agric.

Appointed by the Union Government Department of Forestry (1) :

C. E. Lack, Esq., B.Sc.

The Director :

Professor H. Shaw, M.Sc.Tech., Ph.D., F.R.I.C.

Honorary Secretary :

P. G. Leeb-du Toit, Esq., B.Com. (Registrar, University of Natal).

STAFF

(SEPTEMBER, 1954)

DIRECTOR :

H. Shaw, M.Sc.Tech., Ph.D.(Manc.), F.R.I.C.

Silviculture :

S. P. Sherry, M.A.(Oxon.), B.Sc.(South Africa).

J. C. Parkinson, B.Sc.For.(Stell.). (*Appointed January*, 1954, *resigned August*, 1954).

Technical Assistants :

M. J. Lourens.

I. J. Meiklejohn.

T. B. Oatley.

Genetics and Plant Breeding :

A. A. Moffett, B.Sc.(Birm.), Ph.D.(Lond.).

Miss K. M. Nixon, M.Sc.(Natal).

Technical Assistant:

G. W. Adams.

Chemistry :

W. S. Martin, Ph.D., D.Sc.(Lond.), A.R.C.S., D.I.C., A.R.I.C.

C. G. Gordon-Gray, B.Sc.Hons.(Natal).

Technical Assistant:

R. A. Jones (*Appointed July*, 1954).

Entomology :

L. L. J. Ossowski, M.F., For.Ing., D.Sc.(Poznan).

R. Boyce, B.Sc.Hons.(Durham). (*Resigned May*, 1954).

C. N. Smithers, M.Sc.(Rhodes), F.R.E.S. (*Appointed August*, 1954).

Technical Assistant:

G. B. Wortmann.

Administration :

Miss E. K. Smith.

Non-European :

Seven.

Field Experiment Station Overseer (S.A.W.G.U.) :

M. A. Stewart.

FOREWORD

The presentation of the Administrative Section of the Report has been modified somewhat to bring it into more balanced relation to the remainder. Although the time demanded by administration grows no less, the work itself is now largely routine and to some extent repetitive. Consequently, the record of it no longer merits quite the emphasis that was reasonable during the earlier development phase of the Institute's existence. This Section, therefore, appears under a single main heading, the various major headings previously used now being reduced to sub-headings. The rest of the Report remains unchanged in layout.

Two contributions which are likely to be of immediate value to growers are to be found in the growers' bulletin section of the Report. The first of these, on the control of bramble, describes work which is not yet quite complete in the detail necessary for a formal scientific publication, but which has progressed far enough to justify making recommendations for practical measures of control. The other, on the protection of timber stacks against borer, reports a successful exploratory trial which, because it falls outside the scope of the Institute's activities, should now be taken up and developed by the timber industry.

The Report reveals many examples of the continuing growth of the Institute's advisory work and suggests that the time may not be far distant when the addition of a specialist advisory officer to the staff would be fully justified.

For the first time, expenditure for the year exceeded £20,000, but apart from salaries, is not likely to increase much further unless the scope of the Institute's work is widened. This figure emphasizes the disparity of the Government contribution as compared with that received by other State-aided Institutes, for at £5,000, it now stands in a ratio of 1 : 3 to the amount provided by the South African Wattle Growers' Union.

H. SHAW, *Director.*

October, 1954.

ADMINISTRATIVE REPORT

BUILDINGS AND PLANTATIONS

Main Building.

In addition to minor repairs and additions, the damaged floor in the Library was reinstated and all the wattle parquet floors were re-sanded and polished. They are now in better condition than at any time previously and demonstrate the very pleasing appearance of this wood.

A large new bench was built into the Genetics Laboratory to provide additional accommodation. Plans and specifications were drawn up and estimates obtained for the conversion of a small basement room into a controlled-temperature chromatography laboratory, but this development is in suspense awaiting the collection of basic information on the temperature variations likely to be encountered.

An office on the ground floor has been made available for the accommodation of the Technical Secretary of the Wattle Growers' Union Mechanization Committee. This arrangement is to the mutual advantage of the Institute and the Union and will continue until such time as the room is required for Institute personnel.

Two more of the wall panels painted by Peter Leftwich were delivered and now await framing and erection. A further two remain to complete the set.

Following the occupation of the Natal Agricultural Research Institute in January, the temporary electricity supply line which has been in use since the opening of the Wattle Research Institute was abandoned and connection made with the new transformer house serving both buildings.

Less than the hoped-for progress has been made in cleaning-up and laying-out the surroundings of the building, though further steps were taken in filling-in and levelling where necessary. An important decision in this connection is the agreement in principle of the University Council to accept responsibility for the development of the site as a whole.

Sweetwaters Genetics Station.

A start has been made on harvesting the crop from these trials and it is anticipated that the lease of this site will be terminated within one or two years.

Field Experiment Station.

A further three miles of road have been completed at Bloemendal, making a total of sixteen miles in all. In addition, portions of the more frequently used roads, which tended to become slippery during the rainy season, have been hardened and will now be usable even after heavy rains.

Approximately 160 acres of the farm are now under experiments. A certain amount of frost damage occurred in two blocks re-established during the 1952–53 season and trees up to eight feet in height were killed. A block re-established during 1953–54 lies directly between these two blocks and on the same slope and aspect, but the smaller trees had only occasional young leaves and shoots killed back. The farm continues to show a working profit.

ADMINISTRATION AND FINANCE

The Committee of Control has remained unchanged in personnel throughout the year. Its Chairman, Mr. S. Clegg, has, however, been overseas for a considerable portion of the time and in his absence, Professor A. J. W. Bayer has officiated as Acting-Chairman. Three meetings of the Committee were held during the year, but a number of minor matters were dealt with by the Chairman and the Director in consultation under authority delegated by the Committee. Mr. C. E. Lack was re-nominated as assessor member of the S.A.W.G.U. Field Experiment Station Committee.

Again the Committee has had to deal with a major revision of salaries, this time arising from the partial consolidation of the Civil Service cost-of-living allowances and the consequent adjustments in the basic salary scales. The Institute has again followed the Council for Scientific and Industrial Research in these changes.

The Committee made an important decision during the year in relation to the scope of the Institute's advisory work. The effect of this is to exclude all questions likely to have a bearing on litigation, arbitration, compensation claims, and the like, so lifting from the staff a burden which was beginning to assume disturbing proportions.

Expenditure and Income.

Expenditure during the year was well below the estimate. There was a considerable increase in the total amount of salaries, due to the consolidation of part of the cost-of-living allowance and to concomitant changes in the salary scales. This had not been provided for in the estimates, but was more than offset by the fact that several research posts, for which contingent provision had been made, were vacant for at least part of the year.

It was necessary to replace the Institute's saloon car at a net cost of some £770, and the very large amount of travelling, mainly in the course of the bagworm survey, has further increased the cost of running and maintaining the motor vehicles. On the other hand, there has been no expenditure on overseas travel during the year.

The drop in expenditure on equipment as compared with 1952–53 reflects the fact that the major initial demands for research equipment have now been satisfied. Wherever possible, supplies from overseas have been imported directly, with a very considerable saving to the Institute. The cost of consumable stores remains high, but much of this is due to large purchases of hide powder for bark and extract analysis and is largely offset by the £111 received in fees for this service.

The item of £27 received for wattle bark refers to the collected remnants, accumulated over several years, of samples brought in for analysis from experimental plots spread over the whole wattle area.

The summarized statement of Expenditure and Income for the period 1st September, 1953, to 31st August, 1954, appears below. Detailed accounts and the Balance Sheet are published separately.

RESEARCH INSTITUTE ACCOUNT

1st September, 1953, to 31st August, 1954

Expenditure	£	s.	d.
Research and Administrative Staff Salaries, etc.	15,542	1	10
Travelling and Subsistence	1,036	18	7
Laboratory and Office Equipment and Maintenance..	1,611	4	3
Saloon Car (less trade-in)	770	0	0
Library	167	2	4
Printing and Stationery ..	242	18	2
General Administration	684	0	10
Building Maintenance ..	99	13	9
Electricity Cable Installation	100	0	0
	£20,253	19	9

Income	£	s.	d.
S.A.W.G.U. Grant ..	15,112	9	5
Department of Forestry Grant	5,000	0	0
Analytical Services ..	111	6	0
Witness Fee	3	3	0
Sale of Wattle Bark ..	27	1	4
	£20,253	19	9

STAFF

Changes in the staff during the year have been few and confined mainly to the Assistant Research Officers. The senior post of Plant Physiologist remains unfilled and it becomes increasingly obvious that a Statistician must soon be added to the staff.

Mr. R. Boyce, who was appointed Assistant Entomologist in July, 1953, resigned in May, 1954, on grounds of ill-health and returned to England. He was succeeded in August by Mr. C. N. Smithers, an M.Sc. in Entomology of Rhodes University.

Mr. J. C. Parkinson joined the Institute staff in January as Assistant Silviculturist, but resigned in August to take up a post in the British Colonial Forest Service. It is hoped to fill this vacancy within a few weeks.

The new post of Grade II Technical Assistant created in 1953 was not filled until July, 1954, when Mr. R. A. Jones was appointed. This has brought much-needed relief to the Chemistry Section, where Mr. Jones is now responsible for all routine analytical work.

No award of the Wattle Research Institute Scholarship was made for 1954.

Students from the Faculty of Agriculture were employed to assist in the seasonal work of the Entomology Section, mainly on bagworm surveys.

ADVISORY WORK, COMMITTEES, CONFERENCES, ETC.

Advisory.

The increase in the number of advisory letters written continued unabated and brought the total for the year to 350. Over 330 of these answered enquiries from Southern Africa, including the Rhodesias, but the remainder were spread over ten different countries among which Ceylon, Germany, and Israel appeared for the first time. Just over half the letters referred to insects and pest control (180) while silvi-

culture and allied topics accounted for 83. Many other enquiries were answered by telephone and in person and there was also a sustained demand for Institute publications. A number of industrial concerns have been advised on technical questions, particularly in relation to timber utilization and pest control materials, and information has been supplied to several banks and insurance companies on commercial aspects of the industry.

The Silviculturist paid 31 advisory visits to growers' plantations spread over Natal and the South-eastern Transvaal, while the Entomologist paid 86 such visits in Natal, Zululand, East Griqualand, and Pondoland. In addition, the Entomology Section supervised the aerial spraying of 1,200 acres of wattle on four estates in the 1953 bagworm control campaign. In preparation for the 1954 campaign, 12,000 acres of plantations were surveyed, of which 8,000 acres were recommended for spraying.

At approximately 100, visitors to the Institute were about the same in number as in the previous year. Notable among those from overseas were Dr. Gertrude Cox, Director of the Institute of Statistics in the University of North Carolina, Mr. Ralph Derby of the Forestal Land, Timber and Railways Co., Ltd., London, Professor John P. Conrad of the University of California, and Professor Oliver Roberts of University College, Cork. Other visitors came from Kenya, Tanganyika, Australia, Germany, Holland, Sweden, and Switzerland.

On the 18th March, the first Farmers' Field Day at Bloemendal was held and 162 growers and friends attended. Conditions were almost perfect for the occasion and the visitors maintained a keen interest throughout the day and were most enthusiastic in their praise. A number of smaller parties and individuals, including a group of Agriculture students, also visited the farm and several practical demonstrations were arranged there by the Silviculture Section.

Among the public bodies who consulted the Institute on special matters were the Local Road Transport Board, the Natal Town and Regional Planning Commission, the Interafrican Bureau of Soils, the Imperial Institute, London, the Union Government Department of Forestry, the Forestry Commission of New South Wales, the Natal Provincial Roads Department, the Land and Agricultural Bank, the Food and Agriculture Organization of the United Nations, the Scientific Council for Africa, the British Standards Institute, the South African Chemical Institute, and the Belgian and United States Consulates. Some of these enquiries and consultations were of a confidential nature, but among the others, one or two were of special interest. The discussions with the Department of Forestry concerned the drafting of amending regulations to close loopholes which had been found in the legislation designed to exclude silver wattle from the trade in wattle bark. At the request of F.A.O., their forestry expert in Ceylon was advised on the sampling of trees in small wattle plantations in that country and arrangements were made for the analysis of the samples. A lengthy correspondence with the British Standards Institute has resulted in a revision of the *Acacia* section of the Universal Decimal Classification along lines first suggested by the Wattle Research Institute.

More and more students are making use of Institute facilities in carrying out research projects and preparing theses. A special case is the collaboration with a South African student at Cambridge University in an economic survey of the Union's wattle industry. This study has been greatly assisted by the co-operation of the Transvaal and Orange Free State Chamber of Mines, South African Pulp and Paper Industries, Ltd., and several private growers, all of whom have provided valuable information. A number of schools have been supplied with descriptive literature on the wattle industry and with demonstration samples of its products.

The Entomology Section was responsible for collating and analysing the growers' reports on the bagworm situation in 1954 and later assisted the S.A.W.G.U. office in preparing the schedules of areas approved for aerial spraying.

The Chemistry Section has continued the check analyses of the Government Bark Inspector's samples and has also furnished certificates of independent analysis required for several export consignments of wattle extract.

The Institute was responsible for part of the Wattle Industry Exhibit at the 1954 Royal Agricultural Show in Pietermaritzburg. This section depicted in model form the Field Experiment Station Bloemendal as it was when taken over by the Institute and as it will be at the end of the first full cycle. The two models were made the focus of talks on good practice in wattle farming. Because of its nature, this exhibit had to be prepared almost wholly by the Institute staff and made very heavy demands upon them. The result appears to have been considered worth the time and energy expended. The exhibit is now permanently housed at the Institute as a demonstration piece.

Committees, etc.

The Director attended the Annual Meeting of the Leather Industries Research Institute Research Advisory Council held in Grahamstown in June, 1954, and on the following day represented the Wattle Research Institute at the official opening of the South African Wool Textile Research Institute. A meeting of the Leather Research Institute Wattle Technical Committee was held during the same visit ; an earlier meeting in Pietermaritzburg in November, 1953, was attended by the Director and Dr. Martin.

The Director attended all the meetings of the General Committee of the Wattle Growers' Union and, along with Mr. Sherry, was a member of the Union's Field Experiment Station Committee and Royal Show Exhibit Committee. He served, along with Dr. Ossowski, on the Union's Pest Control Sub-Committee and was also a member of the Mechanization Committee. Mr. Sherry served during the year on the Committee of the Pietermaritzburg Botanical Society.

The Chemistry Section continued its collaboration and discussions on the sampling and analysis of wattle bark and extract with the Wattle Extract Manufacturers' Technical Committee.

Conferences, Lectures, Meetings, etc.

The Director read a paper on "Current Trends in Wattle Research" before a meeting of the South African Chemical Institute and joined with Mr. Sherry in a lecture on the wattle industry to the University Agriculture Students' Scientific Society.

By invitation of the Director of the Natal Agricultural Research Institute, members of the staff attended the Regional Conference of the Department of Agriculture held in May and contributed to the discussions.

Mr. Sherry addressed a meeting of farmers at Greytown on the subject of wattle management in relation to soil conservation and also joined in a general discussion on wattle topics with growers at Commondale.

Dr. Ossowski addressed meetings of the local Farmers' Associations in Kranskop and in Eston on wattle protection and the assessment of bagworm infestation.

During the year, the Institute acquired a modern slide projector and, having built up an extensive collection of suitable coloured slides, is now in a position to give illustrated lectures and addresses on various aspects of wattle production and research.

LIBRARY

While fewer books were acquired during the year, the number of bulletins, reprints, etc., received increased. The numbers were 13 and 222 respectively, giving total holdings of 218 and 1,507. The Library also includes 198 bound volumes of periodicals. Five new periodicals and one new report were added to the list of those received.

The Institute is indebted to Dr. F. N. Howes, of the Royal Botanic Gardens, Kew, for the gift of a copy of his new book " Vegetable Tanning Materials " and to Messrs. E. I. Rogoff, Ltd., of Durban, for a copy of " Papyrus." The Institute is also deeply grateful to the many organizations, particularly in the United States, who make liberal distributions of very valuable literature.

A list of publications available on request to the Institute was published in last year's Report.

ACKNOWLEDGEMENTS

The Institute gratefully acknowledges its indebtedness to the undermentioned for assistance rendered during 1953–54.

To the Natal Provincial Roads Department for drawings of approved cattle grids.

To Messrs. Arthur Collins & Son (Pty.), Limited, for very patient co-operation in devising methods of pulverizing green bark, and to the Natal Tanning Extract Company, Limited, for facilities for chopping large quantities of bark.

To the Chemistry Department, University of Natal, for facilities for the large-scale extraction of buchu leaves.

To Professor A. A. Rayner, of the Faculty of Agriculture in the University of Natal, for assistance in the analysis of field data.

To Dr. H. K. Munro, Collection Entomologist in the Division of Entomology, Pretoria, for suggestions in the selection of common English names for some wattle insects.

To Dr. R. F. Lawrence, of the Natal Museum, for identification of specimens of the order *Arachnida*.

To the Entomologists of the Commonwealth Institute of Entomology and of the British Museum (Natural History) for assistance in identifying entomological material.

To Mr. J. Gibson, of the Windy Hill Wattle Company, and his field staff for untiring assistance during the organization and execution of the aerial spraying experiment.

To the many growers who have provided facilities for conducting experiments in their plantations and who have co-operated in collecting seed of unusual strains of wattle, in reporting the incidence of wattle insects, and in sending material for the Institute's insect collection.

To the management and research officers of the Natal Tanning Extract Company, Limited, for copies of internal reports on matters of interest to the Institute.

REVIEW OF WORK IN PROGRESS

(a) SILVICULTURE

1. Thinning Experiments.

(*a*) Experiment No. S.1 at Broadmoor (Wartburg district) was re-measured in August, 1954. An analysis of the data showed that at five and a half years of age, plots at densities of 650 and more trees per acre were significantly suppressed (P=0·05) in relation to plots with densities of 500 and less per acre.

(*b*) Experiment No. S.3 at Bloemendal (Pietermaritzburg district) was measured in January, 1954. At three years of age, plots at densities of 700 and more trees per acre were significantly suppressed in relation to plots with densities of 600 per acre and less.

(*c*) Experiment No. S.5 on the Clan Syndicate Estate (Albert Falls district) was thinned and measured in July, 1954. At two years of age on this site, there was no significant difference in the growth rate of dominant trees in plots over the range of densities between 400 and 1,400 per acre.

(*d*) Experiment No. S.8 at Bloemendal received its final thinning in March, 1954, at two years of age, and was measured for diameter. The thinning treatments applied in this experiment were as follows :

(i) Seedlings spaced to 6 feet apart in 6 foot rows at 7 months of age and to 12 feet apart at 15 months, then thinned finally to 500 trees per acre at 21 months of age.

(ii) Seedlings spaced to 3 feet apart in 6 foot rows when 2 to 3 feet high, to 6 feet apart when 6 feet high, to 800 per acre when 12 feet high, and finally to 500 per acre when 25 feet high.

(iii) Seedlings spaced to 6 feet apart in 6 foot rows when 2 to 3 feet high, to 800 per acre when 12 feet high, and finally to 500 per acre when 25 feet high.

At two years of age, when plots in treatments (ii) and (iii) had received their final thinning, there was no significant difference in mean breast height diameter between the three treatments.

(*e*) Experiment No. S.10 was measured during July, 1954, at one and a half years of age. As was to be expected at this early age, the plots thinned early to 900 trees per acre showed no measurable degree of suppression in relation to those thinned more heavily.

(*f*) Experiments No. S.11 and No. S.12 have been established at Bloemendal in continuation of studies on time of onset of suppression in relation to stand density which were begun last year. These experiments now cover a range of densities from 100 to 40,000 trees per acre.

2. Thinning and Weeding in Relation to Disease Incidence.

(*a*) Experiment No. S.2 at the Umvoti Wattle Company Estate (Kranskop district), the treatments in which were described in detail in the Report for 1952–53, was again measured and scored for disease incidence in July, 1954. At this scoring, it was found

that lesions on many trees which had previously shown symptoms of gummosis had healed, and such trees were now scored as healthy provided that they gave no indication of having been infected by wood-rotting fungi.

Mean breast height diameters in inches at four years and nine months of age were as follows :

Weeding treatment	Thinning treatment				Mean
	A	B	C	D	
No weeding	4·55	4·55	4·72	4·28	4·53
Weeding by hand-pulling	4·65	4·48	4·68	4·28	4·53
Weeding by hoeing	4·42	4·45	4·55	4·33	4·44
Mean	4·54	4·49	4·65	4·50	

	Weeding	*Thinning*	*Interaction*
Standard error	0·035	0·044	0·092
Significant difference (P=0·05)	0·11	0·12	0·26
Significant difference (P=0·01)	0·16	0·17	0·35

Differences in mean diameter between hoed and hand-pulled plots were no longer significant, but the reduction in diameter due to hoeing was still apparent. Mean diameter in the unweeded plots was the same as that in the hand-pulled plots.

The C thinning treatment produced a higher mean diameter than B, and mean diameter in the D treatment was lower than in any other. The D thinning showed inferior growth to the A, B, and C treatments in unweeded plots and to the A and C treatments in hand-pulled plots, but in the hoed plots, growth differences were not significant.

The percentages of trees which showed symptoms of gummosis or of wood-rot infection, or which had died, were as follows :

Weeding treatment	Thinning treatment				Mean
	A	B	C	D	
No weeding	6·33	3·33	6·33	3·67	4·92
Weeding by hand-pulling	9·67	6·67	9·00	4·67	7·50
Weeding by hoeing	14·38	4·67	14·00	5·67	9·68
Mean	10·13	4·88	9·78	4·67	

	Weeding	*Thinning*	*Interaction*
Standard error	0·685	1·110	2·354
Significant difference (P=0·05)	2·16	3·16	6·70
Significant difference (P=0·01)	3·07	4·22	8·95

There were more diseased trees in hand-pulled and hoed plots than in unweeded plots.

Overall, the B and D thinning treatments were found to have fewer diseased trees than the A and C, largely due to the pronounced differences in hoed plots.

It would appear, therefore, that the incidence of gummosis tended to be higher in stands which were thinned in such a way as to keep them virtually free-growing than in stands in which a certain amount of mutual suppression occurred between thinning operations. This result is in line with the observation that it is commonly the larger and more vigorously growing trees in the stand which show symptoms of gummosis, while suppressed or dominated trees are less often affected by this disease.

Of the two thinning treatments with the lowest incidence of disease, the B treatment has shown appreciably the better rate of growth and is, therefore, to be preferred to the D treatment. The B treatment consisted in thinning to 3 feet apart in 6 foot rows when the seedlings were 6 inches high, to 1,200 trees per acre at an average height of 6 feet, to 700 at an average height of 15 feet, and to 500 at an average height of 35 feet. It is thought that this final operation could be carried out at an average height of 25 feet with advantage and without affecting the incidence of disease.

(*b*) Experiments No. S.9 and No. S.15 at Bloemendal were thinned during the year, but are still too young for measurement or gummosis scoring.

3. Effect of Season of Green Pruning upon Disease Incidence.

Experiment No. S.6 at Bloemendal was measured and scored for disease incidence in July, 1954, six months after the last of the pruning treatments had been carried out. Plots consisted of 20 trees, of which half were live-pruned to eight feet by saw and half with pruning shears, the branches being severed as close to the stem as possible. Pruning was carried out at the end of March, May, July, September, and November, 1953, and January, 1954, each treatment being replicated eight times. Measurements indicated that time of pruning had no significant influence upon diameter increment.

The percentages of trees which showed symptoms of gummosis or wood-rot infection, or which had died, were as follows :

Time of pruning	Method of pruning		Means
	Saw	Shears	
March/April	58·8	50·0	54·4
May/ June	23·8	33·8	28·8
July/August	11·3	8·8	10·0
September/October	17·5	25·0	21·3
November/December	42·5	36·3	39·4
January/February	90·0	77·5	83·8
Mean	40·6	38·5	

	Time of pruning
Standard error	3·31
Significant difference (P=0·05)	9·51
Significant difference (P=0·01)	12·75

Time of pruning had a highly significant effect upon disease incidence, and trees pruned at the end of July showed less disease than trees pruned at any other time of the year. Pruning between January and April produced a higher incidence of disease than pruning during the remainder of the year.

These results show clearly the high incidence of disease resulting from unnecessarily heavy pruning of side branches and indicate also the advisability of carrying out any necessary pruning of basal shoots, or of forks resulting from froghopper attack, during July.

4. Effect of Phosphatic Fertilizers upon Disease Incidence.

Experiment No. S.21 was laid out at Bloemendal in February, 1954, to determine the effect, if any, of various types of phosphatic fertilizers upon gummosis incidence.

5. Effect of Inter-row Cultivation upon Disease Incidence.

Experiment No. S.24 was laid out at Bloemendal in March, 1954, to compare the effect upon disease incidence of disc-cultivation to control weeds between ten-foot rows and of weed control by hoeing between six-foot rows. Cultivation will be con-

tinued for varying periods, and the economics of the different treatments, as well as their effect upon tree growth, will be studied.

6. Effect of Contour Furrows upon Survival of Seedling Regeneration on Dry Aspects.

A small block of plantation at Bloemendal on a hot dry site with a northern aspect was selected for this trial (Experiment No. S.17). The block was divided into four plots, each roughly half an acre in area, and in two of these, selected at random, contour furrows about one foot deep and two feet in width were dug before the standing crop was felled. The soil excavated in digging the furrows was banked on the downhill side to increase their effective depth, and brushpiles and seed-beds were laid out in straight parallel lines across the slope so that these often crossed the furrows.

Counts of the total numbers of seedlings in sub-plots 0·1 acre in area, laid out within the four large plots, were made in August, 1954. These counts showed that there was a significant difference ($P=0·05$) in seedling survival between plots with and without contour furrows in favour of the latter. Closer examination of the plots revealed that survival rate was particularly low in tree rows which ran for some distance along the mounds of loose soil which had been dug out in making the furrows. When survival in rows which did not traverse either furrows or mounds of loose soil was compared with that in corresponding rows of plots without furrows, it was found that differences were not significant.

7. Comparison of Regeneration Established before and after the Winter following Clear-felling.

Experiment No. S.19 was begun on a poor, dry site at Bloemendal clear-felled in February, 1953. Two sets of plots were re-established by sowing treated seed in drills, the one just prior to felling the standing crop and the other in the following October. In the latter, it was necessary first to hoe out the dense growth of grass which had developed.

Seedlings in the plots established before winter made very little top growth during the winter months and were about six inches in height when germination took place in the plots established after winter. Height measurements made in August, 1954, however, showed that the plots established before winter averaged 3·33 feet taller than those established after winter, a difference which was highly significant ($P=0·01$).

(b) GENETICS AND PLANT BREEDING

1. Breeding.

(*a*) *Green wattle* (Acacia decurrens). The families of green wattle comparing open-pollinated progeny of a number of trees with their second (S_2) inbred generation were scored for the second time for height and for the first time for diameter. The relative differences were of the same general order as those of the previous season, but percentage differences in height between the S_2 generation and open-pollinated progeny were not so marked. Excluding tree G28, which appears to be anomalous in behaviour, the 1954 scoring showed that S_2 families were 12 to 37 per cent. shorter than the corresponding open-pollinated families compared with 19 to 46 per cent. in 1953. S_2 families were 10 to 47 per cent. less in diameter than the corresponding natural families.

Open-pollinated progeny of G28 and its S_2 generation showed little difference in height or diameter. The S_2 was 3·6 per cent. shorter than the natural progeny, but was 14 per cent. greater in diameter. Neither difference was significant. Both natural and selfed families segregated for a recessive gene causing the trees to have a short, bushy habit and in both, the ratio of normal to recessive fitted well with a 15 : 1 expectation. It is unlikely that contamination was responsible for the similarity of the ratios, since the segregation was homogeneous over all eleven bagged branches which

comprised the selfed family. The segregation further supports the earlier deduction that with open-pollination, G28 was selfed to about the same extent as when crossing was prevented by bagging (Philp and Sherry, 1946).

(*b*) *Interspecific hybrids.* Leaf samples for measurements of leaf characteristics were taken from F_2 families, back-crosses to black wattle (*Acacia mollissima*), and open-pollinated progeny of green x black wattle hybrids. In all, six leaves were taken from each of some 700 trees. On collection, leaves were immediately dipped into 95 per cent. alcohol to prevent them going into the closed-up condition and were then pressed in the field. Measurements of pinnae and pinnules in the laboratory on the pressed leaves proved to be slow and laborious and at the time of writing had not been completed. It is evident, however, that a wide range of variation and re-combination occurs and the data should yield valuable results when fully analysed. The same families are also being scored for date of flowering, time taken to ripen seed, and prominence of stem ridges.

In the families from interspecific cross-pollinations made in 1950 and 1951, the occurrence of a number of hybrids has now been confirmed.

Out of 12 seedlings which survived from black wattle x *Acacia baileyana*, 6 proved to be hybrids, while from black wattle x green wattle pollinations, there were 3 hybrids amongst 13 seedlings. Black wattle pollinated by silver wattle (*Acacia dealbata*) gave 4 hybrids out of 12 seedlings and all 4 surviving seedlings of silver wattle pollinated by green wattle were hybrids. This is the first time we have been successful in making silver wattle x green wattle hybrids and black wattle x silver wattle hybrids under controlled conditions, although the latter occur naturally with some frequency.

In all families, irrespective of the species involved, hybrid seedlings had chlorotic first seedling leaves, while all non-hybrids had normal blue-green seedling leaves. Three out of four of the silver wattle x green wattle hybrids were chimaeras of green and pale yellow-green tissues.

(*c*) *Black wattle selfed.* Twelve selfed families of black wattle sown in September, 1952, were scored in the field in March, 1954, when a number of recessive characters were recorded. There is some evidence of linkage between dwarf habit, curly leaves, and reduced leaves, but further data are required to establish definitely whether or not linkage exists.

A considerable number of selected trees were bagged for selfing in October/November, 1953.

2. Tetraploidy.

Six families from open-pollinated seed of tetraploid trees were grown in pots in order to determine to what extent inter-crossing with diploids occurred. Parent trees were growing intermingled with diploids in such a manner that a preponderance of diploid pollen would be expected. Chromosome counts were difficult and in some seedlings it was possible to determine the number only to within one or two chromosomes. The tetraploid number $4x=52$ was counted in 72 seedlings, while a further 31 were very close to tetraploid, but the exact number of chromosomes could not be determined with certainty. Five seedlings were definitely aneuploid with $4x \pm 1$ or 2 chromosomes. Only two triploids occurred, one of which was a true triploid with $3x=39$ chromosomes, while the other was an aneuploid with $3x-1$ chromosomes. It would seem that under natural conditions, little inter-crossing between tetraploids and diploids can be expected.

In the same families, and also in two diploid families, measurements were made of the stomata on the first seedling leaf to determine with what degree of accuracy tetraploids could be identified by such measurements instead of by laborious chromosome counts. For the most part, the range of size of the tetraploid stomata was outside that of the diploid stomata, but a few plants in two tetraploid families had small stomata

which fell within the range of the diploids. It was concluded, however, that if seedlings are of the same age and grown under the same conditions, measurements of stomata on the first seedling leaf will serve to identify the great majority of tetraploids.

3. Progeny Testing of Parent Trees.

(*a*) *Progeny tests at Bloemendal.* Routine progeny testing of trees to locate superior parents has been continued at Bloemendal. The second progeny test was scored for height and diameter and again highly significant differences occurred between families.

A start was made on the vegetative propagation of all parent trees likely to be of value in the breeding programme. Air-layers for vegetative propagation have now been made on 56 trees.

(*b*) *Progeny trials at Sweetwaters.* Two progeny trials planted at Sweetwaters in March, 1943, were felled in April, 1954.

The first of these trials consisted of a comparison of 14 families of black wattle. Eleven of these were the open-pollinated progeny of selected trees, the seedlings being thinned at random without any selection for vigour. From two of the trees, a second family was included in which thinning was carried out so that the most vigorous seedling remained at each position. A family grown from commercial seed, i.e., bulk seed collected from plantation floors, completed the number.

The second trial was on very similar lines, but with selected trees of green wattle instead of black.

In both trials, a number of trees failed to strip. Most of these have been left standing and possibly a few will strip during the coming wet season. For the moment, they have been ignored when calculating yields, partly because failure to strip is an undesirable characteristic and partly because it was considered that the small amount of additional bark that would accrue to the families is unlikely to alter the comparative results.

In black wattle, the progeny of different trees showed highly significant differences in bark yields. The progeny of one tree was significantly higher, that of two others almost so, and that of three trees significantly lower in yield than the commercial family. It would seem, therefore, that selection by progeny tests of the best trees as parents and elimination of the poorest should raise the average above that of the present commercial standard.

The families also differed in stand and mean diameter, but not in height. Yield of bark was positively correlated with stand, mean diameter, and mean height. There was no correlation between mean stand and height or between stand and diameter. The latter result was unexpected, since it is known that in experiments not involving a varietal factor, there is a negative correlation between stand and diameter. In the Sweetwaters trial, varietal factors have evidently outweighed and obscured the negative correlation and, in fact, the family with the poorest stand had the smallest mean diameter.

Comparison was made between measurements taken at the early stages of growth and the final yield. There was a significant positive correlation between the mean diameter measured in March, 1945, when the trees were two years old, and the final yield of bark. Height measured in May, 1946, was also positively correlated with yield of bark, but prior to that date the correlation did not reach the level of significance.

In most instances, relative differences in vigour which appeared between families in the early stages of growth were maintained to maturity. It would seem from these results that a fairly good assessment of the vigour of a family may be made at two to three years of age.

In the green wattle trial, families again differed significantly in yield of bark, stand, and mean diameter, but not in mean height. Diameter and yield were correlated, but there was no correlation between height and yield or stand and yield, possibly owing to a more uniform stand in this experiment than in the black wattle trial. The correlations of yield of bark with diameter and with height at early stages of growth were not significant in green wattle.

In both black and green wattle, there appeared to be no consistent connection between the vigour of the parent tree and the vigour of its offspring. In both species, some of the vigorous parent trees gave poor progeny, while some suppressed trees produced highly vigorous offspring.

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(c) CHEMISTRY

1. Fertilizer Experiments.

The table of responses of wattle in its early stages to nitrogen, phosphate, potassium, and lime applied within three to six months of germination on three different soil types was given in this Report last year. Height measurements have been continued and the table has been brought up to date below :

MEAN HEIGHT IN RELATION TO TREATMENT

(No Treatment=100)

	1950	1951	1952	1953	1954
Honey Grove—Table Mountain Sandstone.					
Nitrogen	100	100	100	†	100
Phosphorus	119*	121*	121*	†	107*
Potash	108*	101	102	†	101
Lime	97	101	103	†	103*
Bloemendal—Shale.					
Nitrogen		103	102	102	100
Phosphorus		110*	109*	109*	105*
Potash		99	104*	104	102
Lime		90*	100	100	101
Clan Syndicate—Dolerite.					
Nitrogen		100	99	99	100
Phosphorus		102*	107*	107*	105*
Potash		99	99	99	99
Lime		104	103	103	102

†Not measured

*Differences significant (P=0·05)

Applications in each case :

Nitrogen	2 cwt. per acre sulphate of ammonia.
Phosphorus	4 cwt. per acre superphosphate.
Potash	2 cwt. per acre muriate.
Lime	5 tons per acre carbonate.

It is apparent that although phosphate maintains its position as the only treatment to show significant improvement on all sites, the magnitude of the difference tends to decrease with time. On the other hand, there is a tendency for the effect of liming to improve with time. On Table Mountain sandstone, the application of lime showed a significant improvement for the first time when the trees were in their sixth year. On dolerite, the effect of lime during the first two years was confused by the differential incidence of froghopper. A subsequent experiment laid down at Bloemendal to investigate the inter-relation of liming and froghopper attack was abortive as there was no froghopper.

The experiments comparing different forms of phosphate still show that fertilizers containing the quick-acting superphosphate are better than ground raw phosphates.

In view of the fact that soluble phosphate appears to be the only fertilizer of immediate benefit to wattle, an experiment has been laid out at Bloemendal to obtain information on the optimum time and mode of application of superphosphate.

The final estimate of the effect of a fertilizer treatment on any crop must obviously be on the basis of yield, in this case primarily tannin and secondarily timber per acre at harvest. Thus, there must be a delay of from eight to ten years before the result is obtained. In the early years of the crop, tree height is the only suitable criterion of the effects of treatment, but as the trees grow, it is evident that heights tend to even out and girth has also to be taken into account. In future, therefore, the interim results of these experiments will be analysed on the basis of an estimated bark weight, a figure calculated on a combination of height and diameter at breast height.

2. Gummosis.

Counts of affected trees in all the fertilizer experiments have been continued, but no significant differences due to treatment have been revealed. It is well to remember, however, that all the experiments have been progressively thinned according to recommended commercial practice, so that many affected trees have been removed at each thinning. As a result, it is probable that the majority of the susceptible types will not appear in the final stand. Many trees badly affected in 1953 have shown remarkable recovery ; old lesions have dried up and calloused and the trees have maintained growth. It remains to be seen whether fungal spores gained entry during the period of active gum formation.

These studies are being continued by annual scoring of individual numbered trees as soon as the final stocking of each experiment is attained.

3. Soil Analysis.

To find out the effect of continuous wattle growing on soil structure, soil samples were taken in a wattle plantation unburnt for 60 years, from adjoining firebreaks cultivated once annually, and from contiguous virgin veld burnt annually. Seven such trios of samples have been examined for acidity and percentage of water-stable soil crumbs over 0·5 mm. in diameter, with the following results :

Site	Wattle		Firebreak		Veld	
	pH	Crumb %	pH	Crumb %	pH	Crumb %
1	4·8	31·1	4·8	33·9	5·5	39·1
2	4·9	61·2	4·9	60·1	5·5	70·2
3	5·1	45·3	5·2	57·9	5·8	59·8
4	5·4	38·4	5·4	47·0	5·8	44·0
5	5·0	41·8	5·0	44·7	5·6	49·5
6	4·7	43·0	5·6	46·3	5·7	46·9
7	5·1	31·6	5·2	36·0	5·6	50·7
Mean	5·0	41·8	5·1	46·6	5·6	51·5

The results confirm the findings of other workers that soil tends to become more acid under wattles. It is clear also that wattles cannot compare with grass in the maintenance of soil structure. Fortunately, under such a tree crop, especially where no burning is practised, the structure of the soil is not such an important factor as it is with field crops because the accumulation of litter breaks the fall of rain drops, assists the infiltration of water, and reduces the loss of moisture by evaporation.

4. Bark Analysis.

(*a*) *Routine analyses.* Work done during the past year includes the routine analysis of approximately 600 bark samples by the Official Method. In addition, 39 samples submitted by the Government Inspector of Wattle Bark were analysed to provide a check upon the physical estimation of tannin content. The measure of agreement between the two evaluations was reasonable.

Co-operative work with the Permanent Technical Committee of the South African Wattle Extract Manufacturers' Association was continued.

(*b*) *Roux's spectrophotometric method of tannin estimation.* An extensive comparison of Roux's spectrophotometric method with the official hide powder method showed that the former may give results greater or less than the hide powder method, depending on the individual bark. Where the percentage of tannin is greater, the difference could be due to some soluble non-tannin component which absorbs light energy in the region of 280 mμ. A spectrophotometric study of some non-tan solutions indicated the presence of such components since, after re-shaking these solutions with hide powder, they still absorbed in the region of 280mμ. Hillis (1954) has recently demonstrated the presence of anthocyanins in wattle extract and it is quite possible that these or like substances are located in the non-tans.

What causes the hide powder method sometimes to give a higher tan content than does the spectrophotometer is not known. It may be that in the absence of any countervailing non-tan substance capable of absorbing in the region of 280mμ, a combination of gum (Roux, 1954) and starch is responsible, since a portion of each is recorded as tans by the hide powder method.

It is possible that the irregularity of the differences between the two methods of tannin estimation is related to genetic factors and environment. In a cross-pollinated population such as wattle, a considerable amount of genetic variation between trees must be expected and individual trees may differ not only in the constitution of the tannin, but also in the other water-soluble portions in bark. The chemical composition of the water-soluble material has not yet been elucidated and consequently, variations in the concentrations of the individual components of this fraction cannot be gauged.

The spectrophotometric method, however, has much to recommend it and should prove useful to factories. Not only is it rapid, but, provided certain conditions are rigidly adhered to, the results are reproducible, differing by less than one per cent. when duplicate analyses are done on different days. The agreement between different laboratories is excellent and the result is normally within ± 3 per cent. of that determined by hide powder.

The necessary conditions are :

(i) All spectrophotometers must be calibrated by using portions from the same sample of extract to obtain the standard curve or by comparison with a calibrated instrument through a common tannin sample.

(ii) The tannin content of the reference extract must be determined in duplicate (Official Method) by a single analyst and the mean result accepted by all analysts as the tannin content of that extract.

(iii) Since the optical density of the diluted benzoic acid solution changes with time, it must be recorded when the standard curve is obtained. Thereafter,

any change in optical density must be allowed for by adding the difference to, or subtracting it from, the apparent optical density of the extract solution being measured.

(iv) Freshly-made sodium bisulphite solution must be used for each set of determinations, since this solution deteriorates if allowed to stand for more than three hours in a partly-filled, stoppered flask.

(v) The bark sample must be completely pulverized.

(vi) The moisture content of the bark must be determined accurately in an oven through which dried air is passed (Gordon-Gray, 1954).

(vii) The bark must be extracted according to the official Procter or Koch method without modification.

(viii) The presence of opalescence or colour in the extract solution after it has been diluted in preparation for the spectrophotometer must be ignored. No attempt must be made to reduce the colour with bisulphite or to remove the opalescence with kaolin or any similar substance.

A collaborative test carried out between the Forestal Laboratories (A) at Harpenden, England, and the Wattle Research Institute (B), gave the following results :

Sample No.	% Tans (spectrophotometer)		% Tans (hide powder)	
	A	B	A	B
30	31·5	31·0	30·2	30·8
31	31·3	31·1	29·9	30·5
32	33·1	32·7	30·1	31·0
33	24·0	23·5	21·7	21·8
34	30·3	30·4	28·8	28·8
35	36·0	35·9	35·7	35·5

It will be seen incidentally from the above table that the hide powder results obtained by the two laboratories are in excellent agreement, bearing out the fact that this method of tannin estimation is reliable.

(*c*) *Variation in tannin content of air-dried bark samples with time.* Ground bark samples analysed during the period August to November, 1952, were re-analysed in the same laboratory during the period July to August, 1954. The results reveal no material change in tannin content :

Tans %		Non-tans %		Insolubles %		Moisture %	
1952	1954	1952	1954	1952	1954	1952	1954
49·2	49·4	10·6	10·5	0·9	1·8	10·9	11·9
44·2	44·3	11·6	11·7	1·0	1·2	10·5	11·6
40·3	40·4	11·7	11·3	0·8	1·4	10·3	11·5
47·2	47·0	10·4	10·1	0·9	1·7	11·1	12·1
46·6	47·0	11·3	10·4	0·8	1·7	10·8	11·8
44·5	44·6	11·5	10·8	1·2	1·8	10·6	11·7
40·9	40·9	10·9	10·7	0·6	1·1	10·1	11·2
50·3	50·5	9·5	8·9	0·9	1·7	10·9	12·4
40·9	40·6	12·3	11·9	1·4	1·7	10·6	11·1
46·5	46·3	11·6	11·4	1·0	1·4	11·2	11·9
42·4	42·2	9·6	9·1	1·2	1·3	11·2	11·6

(*d*) *The extraction of bark samples for analysis.* Roux's spectrophotometric method was evolved primarily to reduce the time required to determine the percentage tannin

in a solution obtained either by extracting a bark sample or by dissolving a quantity of solid extract.

Since extraction of a bark by the Procter method requires four hours, it was decided to investigate the possibility of reducing this time. Preliminary experiments indicated that a modified Procter extraction carried out for two hours at the boiling point of water without the overnight digestion was satisfactory. Accordingly, 21 barks from 15 different estates were extracted in duplicate by the standard Procter method and by the modified Procter method (two hours at boiling point) and the extracts so obtained analysed by the Official Method. Agreement in tannin content within 0·6 per cent. between the two methods of extraction was obtained in 18 barks, but in the remaining 3, differences as large as 1·2 per cent. were obtained.

Later comparisons, however, showed that even greater differences in tanning content between the two methods of extraction are possible. The content of insolubles is usually greater in the modified extraction, with consequent decrease in the filtration rate.

(*e*) *Oven drying of green bark samples for analysis.* Preliminary work on the effects of oven drying of green bark samples on the tannin content obtained by analysis has shown that in certain barks, oven drying lowers the tannin content. This method of drying green bark cannot, therefore, be employed.

(*f*) *Colour in green bark extracts.* Investigation has shown that because of the much greater degree of oxidation involved in drying the bark for analysis, the colour of a green bark as determined analytically bears little relation to the colour of the commercial extract obtained from that bark.

(*g*) *Seasonal effects on extractives in wattle bark.* A preliminary survey on the seasonal variation in extractives of wattle bark during the stripping period, carried out on one plot at Bloemendal, indicates that although the tannin content remains fairly constant, there is a very marked drop in the non-tan content round about mid-summer.

No. of trees	Month	Average % tannin	Average % non-tans
31	October	32·0	15·8
10	December	33·1	16·1
6	January	34·7	10·5
6	February	33·7	10·2

This work is being followed up and data will be collected over a number of years.

(*h*) *Tree and plot sampling.* Work on the sampling of individual trees and plots of different size has been in progress for the past five months.

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(d) ENTOMOLOGY

1. Bionomy of Wattle Bagworm.

(*a*) *Biotic potential.* Data were obtained from 29,805 bagworms for the determination of sex ratio and factor, and from 39 females for the average number of eggs It was found that the sex ratio was 1 female to 1·2 males and the sex factor 0·45. The number of eggs per female averaged 1,279. The annual biotic potential was 575, while the biotic balance amounted to 99·83 per cent.

2. Development of Starving Bagworms.

Bagworm larvae which in their later instars were taken from completely defoliated wattles and pines (*Pinus patula*) and kept in the insectary for observation were retarded in growth, but pupated. The natural mortality reached 90 per cent. Males which emerged were unable to copulate and all females which survived had shortened or deformed oviducts and shrivelled up without producing a progeny.

3. Effect of Bagworm Attack on Increment.

All increment plots except those at Geluk in the Transvaal were checked and sprayed in November/December, 1953, and again examined and measured in co-operation with the Silviculture Section in July, 1954. Because of severe hail damage, the plots in the Transvaal were neither sprayed nor measured. The total number of increment sample plots at present is 76, distributed over eight plantations. In addition, 16 new plots were laid out in Windy Hill in the experimental area sprayed from the air in 1953 and were measured immediately after spraying and for the second time in July, 1954. This last trial was designed to demonstrate the effect of bagworm attack in the last years of growth before felling.

4. Wattle Bagworm Survey in Thornveld.

Approximately fifteen square miles of thornveld were surveyed in the Estcourt, Ladysmith, and Eston areas, also around Greytown, Windy Hill, Umlaas Road, and Nagel Dam in order to determine whether dangerous breeding grounds exist there and whether bagworms are still infiltrating cultivated wattles from the thorns. Breeding centres with defoliated thorns were found around Estcourt and Ladysmith and in the Eston area, but they were all from 15 to 30 miles from the nearest commercially-grown wattle plantations. North-east of Greytown, a few bagworms were found in thorns near wattles, and in the Windy Hill area, a single worm was found on some three square miles.

Bagworms collected from the thornveld were placed in the insectary for determination of the species of parasites attacking them. The mortality due to parasites was slightly below ten per cent. and the species parasitizing these bagworms were the same as are prevalent on bagworms from cultivated wattle plantations, viz., *Philopsyche abdominalis* Morley, *Carcelia evolans* Wied., and *Tachina fasciata segregata* Rond. Further investigations are in progress.

5. Chemical Control.

(*a*) *Aerial spraying experiment.* A replicated experiment was carried out at Windy Hill in November to test the effect of Toxaphene in Diesoline, sprayed from the air at two different rates, on bagworms up to the third instar and on other wattle insects. An account of this experiment is given on page 49 of this Report.

(*b*) *Use of repellents and deodorants.* A duplicated experiment, the start of which was timed by a copulation clock registering the beginning of the copulation period, was carried out in July, 1953, with materials reputed to have repellent or deodorant properties. These comprised emulsions of citronella oil, Mexican marigold oil, eucalyptus oil, methyl salicylate, nitrobenzene, Toxaphene, and BHC, aqueous solutions of

asafoetida, paraldehyde, " ultra-violet activated " chlorophyll, and ammonium chloride, a suspension of chloride of lime, solutions of Toxaphene and BHC in Diesoline, and Diesoline alone.

Trees carrying 30 bags with unfertilized bagworm females and 15 male bags with unemerged adults were sprayed at a rate of five gallons per acre. Some time after the first signs of hatching, the female bags were examined to determine whether the insects had been fertilized, left the bag, or died without producing a progeny. The male bags were also collected and their contents examined. All bags from treated trees, except those sprayed with Mexican marigold, chloride of lime, or ammonium chloride, showed normal development and a natural mortality from 30 to 50 per cent., i.e., similar to that of bags from control trees. Bags sprayed with Mexican marigold included 25 (83·3 per cent.) which were empty or contained dead females and unfertilized eggs. Two bags were parasitized, and young bagworms had emerged from only three bags. All male bags showed traces of emerged adults. In bags treated with ammonium chloride, three females were parasitized ; the remainder (90 per cent.) were dead and the eggs unfertilized. Six fully developed adults were found dead in the treated male bags. Bags from trees sprayed with chloride of lime had 28 dead females (93·3 per cent.) with unfertilized eggs, and two which were parasitized. Five male bags contained fully developed, but dead, males. Bags treated with ammonium chloride or chloride of lime had a hard covering of dry residue one day after spraying. This probably accounts for males being unable to leave the bag. It appears that Mexican marigold has repellent or masking properties, while the action of ammonium chloride and chloride of lime seems to be largely mechanical.

Methyl salicylate appeared to have some power of attraction. Copulation was particularly active in sample trees sprayed with this chemical and could be observed there more frequently than in sample trees treated with the other substances.

The experiment was continued in 1954, when an emulsion of oil of buchu, a *Barosma* species, was used.

6. Predators on Wattle Insects.

A wasp preying on larvae of all instars of *Achaea lienardi* Boisd. was identified as *Philanthus loefflingi* Dahlb. (*Sphegidae*).

7. Identification of Wattle Insects.

A lasiocampid attacking plantations in the Transkei was identified as *Mesocelis montana* Cram., beetles damaging wattles in the Midlands of Natal as *Eunidea strigata* Fhs. (*Lamiidae*) and *Sinoxylon ruficorne* Fhs. (*Bostrychidae*), and termites destroying young plantations mainly on the southern border of Zululand as *Hodotermes mossambicus* (Hagen). Further details of these insects are given on page 44 of this Report.

8. Records of Insect Outbreaks.

These records contain at present data concerning 37 species on 168 farms and plantations.

9. Wattle Insect Collection.

The collection of wattle insects started in 1953 at present contains 56 species.

10. Miscellaneous Insects not associated with Wattle.

Lyctus Powder Post Beetles. A replicated pilot experiment was laid out to test the efficacy of DDT, BHC, and Dieldrin, each dissolved in Diesoline, against the wood borer, *Lyctus brunneus* (Steph.). Stacks of *Eucalyptus saligna* boards infested with borer were treated in June by means of an insecticidal fog generator. The experiment was repeated in November.

The results with DDT and BHC were very promising and justify continuation of the work by the timber industry. A note giving details of this experiment appears on page 56 of this Report.

(e) MISCELLANEOUS

1. Weed Control by Chemical Means.

One year after spraying was carried out, a survey of the trial comparing the effect of a range of esters and salts of 2:4:5-T on American bramble (*Rubus* sp.) indicated that there was little difference in performance between the various compounds. More important appeared to be the condition of the stand when sprayed. Results throughout were better on dense, heavy growth than on sparse, spindly plants, even though the former was much the more difficult to spray thoroughly. Final confirmation of the result should be forthcoming when normal plants come into full leaf in the coming spring.

The series of plots sprayed in 1951 and not subsequently re-treated was inspected over three years later. Although unsprayed controls and ineffective treatments were heavily overgrown with bramble, one of the 2:4:5-T ester plots remained completely free and several others nearly so.

In the course of these experiments, it has been noticed that cane killed by hormone treatment rots down far more quickly than slashed cane in the same conditions.

A growers' bulletin based on these experiments appears on page 54 of this Report.

Diesel oil, 2:4-D, and 2:4:5-T, applied as stem sprays during the winter, proved to be ineffective against aspen (*Populus tremula*) in veld. In a summer treatment, however, 2:4-D and 2:4:5-T showed promise, but the diesel oil was again ineffective. The stems appeared to be killed wherever they were well-wetted by the hormone sprays, but there was a fair amount of new shoot growth from below the damaged portion. As the full effect of these sprays is often long delayed, observations will be continued through the coming growing season. Meantime, further modified treatments will be tried.

Preliminary trials of sprays to control bugweed (*Solanum auriculatum*) and lantana (*Lantana camara*) have been started.

2. Collaboration with other Organizations.

(*a*) *Studies on the tannins of wattle species.* Further samples of fresh wattle bark were collected and despatched to the Leather Industries Research Institute for molecular weight studies on the tannins.

(*b*) *Design of spraying equipment.* Under a scheme which utilizes the good offices of the Council for Scientific and Industrial Research in the Union and the National Research Development Corporation in Great Britain, contact has been made with the National Institute of Agricultural Engineering with a view to their designing and building a prototype insecticidal fog generator. A basic specification for a machine suitable for the spraying of wattles from the ground, especially against bagworm, has been drawn up by the Institute.

(*c*) *Rapid death of wattle trees.* Several organisms isolated from affected material by the Plant Pathology Department of the Natal Agricultural Research Institute were identified, but none was established as the causal pathogen. The little evidence available suggests that climatic conditions were largely responsible for the condition.

PROGRESS REPORTS AND PAPERS

THE EFFECT OF DIFFERENT METHODS OF BRUSHWOOD DISPOSAL UPON SITE CONDITIONS IN WATTLE PLANTATIONS. II. A STUDY OF RUN-OFF AND EROSION DURING THE FIRST TWO YEARS AFTER CLEAR-FELLING AND REGENERATION

By S. P. SHERRY

The amounts of run-off and erosion of litter and soil from a wattle plantation were measured during the first two rainy seasons after clear-felling the old and regenerating a new crop.

Figures are presented to show that method of brushwood disposal had a significant effect upon run-off and erosion, and that the respective rates were correlated with intensity rather than with volume of precipitation. The effect of brushwood treatment was accentuated by slope, though significance could not be established for slope effects *per se*.

Differences in run-off behaviour between the first and second seasons after clear-felling, due to changes in the vegetative cover, are also discussed.

The experiment described in Part I of this series (Sherry, 1953) has now been in progress two years on the Field Experiment Station at Bloemendal, and figures of run-off and litter- and soil-loss for two complete rainy seasons are, therefore, available. These figures, of course, are interim in nature and must be accepted as such. They cannot, however, be changed by subsequent events and almost certainly represent the major part of the action likely to take place during the first crop-cycle of the experiment.

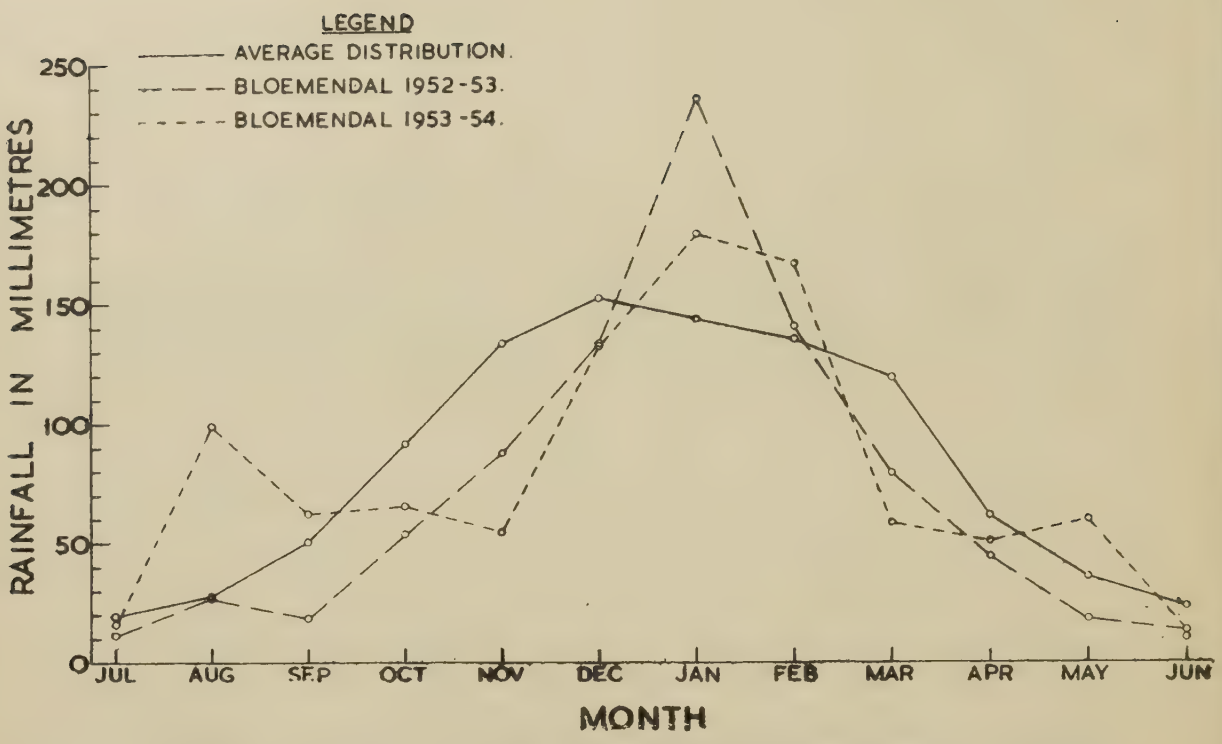
Before dealing with the results of the experiment to date, it is desirable to consider the rainfall in the wattle-growing areas as a whole and at Bloemendal in particular.

Rainfall in the Wattle-growing Areas of South Africa.

The wattle-growing areas in South Africa all lie within the summer-rainfall zone, in which at least 70 per cent. of the total rainfall normally occurs during the six-month period from October to March. There is, however, no clear-cut separation into a wet and a dry season such as is found in some parts of the tropics, and usually some rain falls during each month of the year.

Because of the concentration of rainfall during the growing season, rainfall years are usually recorded from 1st July to 30th June. This cycle has been followed in Text-fig. 1, which shows the rainfall distribution during 1952–53 and 1953–54 at Bloemendal as compared with the average distribution in the main wattle-growing areas. The latter was computed from the mean monthly average rainfall over the past 25 years on thirty wattle estates scattered throughout Natal, Zululand, and the South-eastern Transvaal.

The three graphs follow similar trends, but the last-mentioned has a lower mode than those for the single-year distributions, as would be expected from an average over a number of stations and a considerable period of years. It may be assumed, therefore, that the rainfall distribution at Bloemendal is reasonably representative of that in the main wattle-growing areas.



Text-fig. 1. Comparison of rainfall distribution at Bloemendal during the period of the experiment, with a 25-year average distribution over the main wattle-growing areas.

The mean annual rainfall over the thirty estates contributing to the average graph ranges from 755·65 mm. (29·75 in.) to 1372·87 mm. (54·05 in.) with an average of 992·63 mm. (39·08 in.). Records at Bloemendal are available only for the two complete rainfall-years of this experiment, in which the fall was 858·1 mm. (33·78 in.) and 955·65 mm. (37·62 in.) respectively, but general conditions on the farm suggest that its rainfall is rather lower than the average for the main wattle-growing areas. Thus the results obtained in this experiment are unlikely to give an exaggerated picture of conditions in the wattle industry as a whole.

Experimental Procedure.

The experimental plots were laid out in March, 1952, and the tanks for collection of run-off, litter, and soil were completed in August of the same year. No rains sufficiently heavy to cause run-off occurred during the period between the felling of the standing crop on the experimental area and the completion of the tanks. In order to facilitate measurements of gradient, the brushwood was not placed in position at the time of felling the standing crop, but was carried onto the plots subsequently and stacked or burnt according to the prescribed treatments. When it was moved from where it had been temporarily stacked, it was found that most of the leaf-pinnules had been shed and had fallen through the branches to form a thick layer on the surface of the soil under the pile. Thus the brushpiles did not have the close union with the surface soil which results from the shedding of leaf-pinnules when green brushwood is stacked in the normal manner. Consequently these brushpiles offered less of a barrier than would have been the case had they been stacked initially *in situ*.

The placement of brushpiles as described in Part I was amended slightly in orde to avoid the lower pile being stacked immediately above the spillway in treatments in which this brushwood was not burnt. The brushpile centres in these treatments were, therefore, actually 28 yards apart and not 30 as stated.

All stumps on the plots were sawn off at ground-level in order to remove any possible differential obstruction to run-off and erosion. For the same reason, it was decided to remove any wattle seedlings which appeared on the plots, although it was realized that this would create conditions not strictly typical of normal plantations. Seedlings were removed while still small by cutting the stem just below ground-level with secateurs in order to reduce soil disturbance to a minimum.

Silvicultural treatment of the experimental area conformed with general commercial practice, and cultural operations were carried out contemporaneously over all plots in order to secure uniformity. Thus, at the end of December, 1952, the density of weed-growth in Area 1 made immediate hoeing necessary and, although the weed-cover in Areas 2, 4, and 5 was much less dense, and that in Area 3 quite sparse, all five areas were hoed on the 31st December, 1952. In this hoeing the surface soil was disturbed only where weeds were actually hoed out, and all hoed weeds were left lying *in situ*.

Readings of run-off were taken as soon as practicable after the rain concerned, usually not later than the following morning, and the litter and soil eroded from the plots was then removed from the tanks for drying and weighing before the run-off water was drained off and the plugs replaced in readiness for the next record.

Frequency of Rains causing Run-off and Erosion.

The first rain to cause run-off occurred on 9th December, 1952, and amounted to 22 mm. (0·87 in.) falling within 30 minutes. At this time the wattle seedlings on the experimental area were about twelve inches high and had been thinned to approximately three feet apart in six-foot rows. They did not, therefore, provide any considerable ground cover and their effect in interception of rainfall was probably slight.

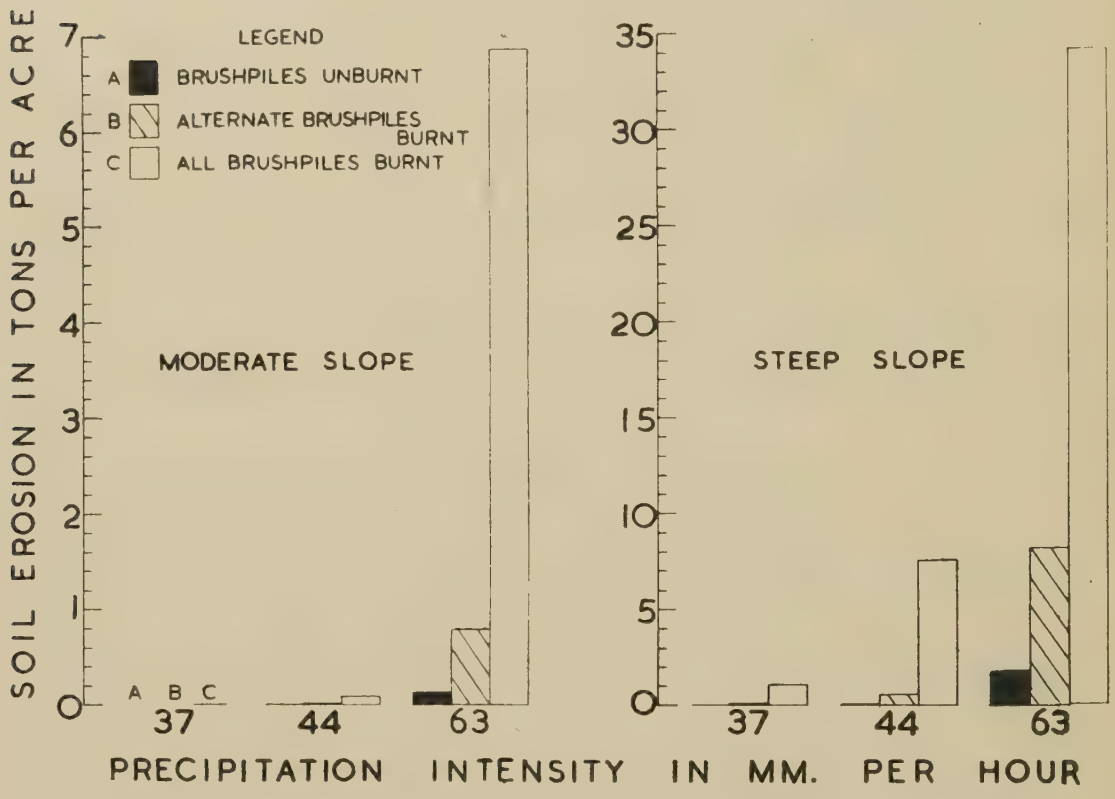
Thereafter, run-off occurred eighteen times during the first rainy season, but on only nine of these occasions was a measurable quantity of litter and soil eroded from any of the plots. Accurate measurements of run-off and erosion were possible for all these rains except that on 3rd January, 1953. On this occasion, flood-water from roads running through the experimental area entered three of the enclosed plots and the readings from these plots for this rain cannot be accepted as accurate, and have been excluded from the analysis of results.

In the second rainy season, run-off was recorded on twenty-one occasions, but on only five of these was the amount of erosion measurable. The considerable reduction in the amount of erosion during the second rainy season was apparently due to the development in the plots of a dense cover of herbaceous annuals and perennial grasses in the spring of 1953. This weed-growth was able to establish itself because of the reduction in crown density resulting from the almost complete defoliation of the trees on the plots by jassids and capsids during February, 1953, and its development was favoured by the excellent rains from August to October.

Run-off and Erosion in Relation to Rainfall.

Run-off and erosion of litter and soil appeared to be mainly affected by intensity rather than volume of rainfall. Table I illustrates the differences in volume of run-off and quantities of litter and soil eroded during rains which were similar in volume, but differed in intensity. Irrespective of the method of brushwood disposal, there was a rapid rise in the rates of run-off and erosion with increasing precipitation intensity.

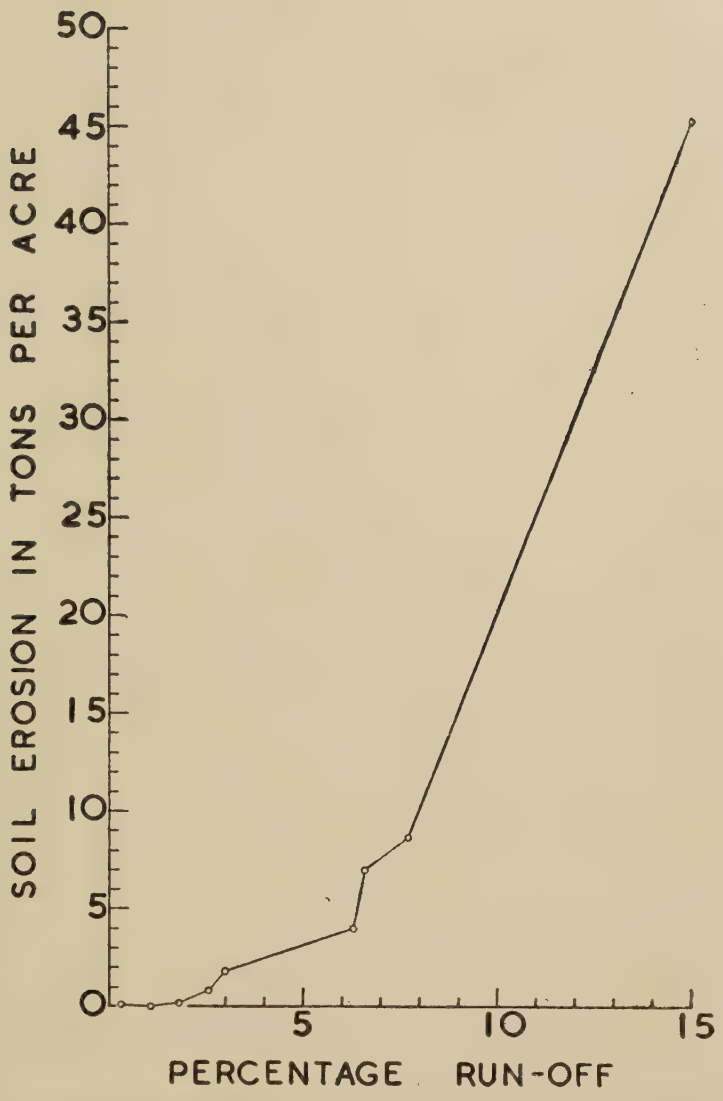
A recording rain-guage was not available during the period of this study, so no accurate determination of precipitation rate was possible. An attempt was made, however, to record the periods of all falls of rain occurring during daylight hours, so the *average* intensities of most of the individual rains causing run-off are known. A study of the average intensities indicated that the minimum rainfall rate capable of causing run-off from the soils of the experimental area, even when these were partially denuded of litter by burning, was approximately five mm. per hour.



Text-fig. 2. Effect of precipitation intensity upon soil erosion with different methods of brushwood disposal on moderate and steep slopes.

Much higher rates than this were required to cause erosion, however, as is shown by the histograms in Text-fig. 2. These were derived from the figures of soil-loss during the three high-intensity storms of short duration mentioned in Table I, the precipitation rates of which could be estimated with a fair degree of accuracy. They bring out clearly the extremely rapid rise in rate of soil-loss with an increase in precipitation intensity from 37 to 63 mm. per hour.

It is probable that raindrop size also contributes to the effect upon soil erosion of increasing rainfall intensity, since high intensity precipitations are characterized by raindrops of large size. Packer (1951) found that considerable displacement, particularly of the coarser particles of the surface soil, could take place as a result of raindrop splash, and it may reasonably be assumed that splash, and consequently displacement, will be positively correlated with raindrop size.



Text-fig. 3. Relationship between percentage run-off and soil erosion during the first rainy season after clear-felling.

Text-fig. 3 shows that the amount of erosion is closely related to the percentage run-off. This is due mainly to the fact that high intensity rains usually give high run-off percentages because precipitation rate has exceeded soil infiltration capacity. Run-off from the soils of the experimental area appeared to be mainly the result of inadequate infiltration capacity, but storage opportunity undoubtedly played a part as well. Thus, in February, 1953, when storage opportunity was low on account of the very heavy rainfall during January, a rain of 44·5 mm. (1·75 in.) over 12 hours caused run-off ranging from 0·2 to 8·9 mm. from the various plots. In August of the same year, however, when storage opportunity was high after the dry winter period, a rain of almost twice the average intensity and more than double the volume, measuring 92 mm. (3·62 in.) in 14 hours, caused a maximum run-off of only 12·8 mm.

TABLE II

Mean run-off and erosion during a single precipitation of 22 mm. (0·87 in.) lasting 30 minutes.

Slope	Run-off in gallons per acre				Litter-loss in pounds per acre				Soil-loss in pounds per acre			
	Brushpiles unburnt	Alternate brushpiles burnt	All brushpiles burnt	Mean	Brushpiles unburnt	Alternate brushpiles burnt	All brushpiles burnt	Mean	Brushpiles unburnt	Alternate brushpiles burnt	All brushpiles burnt	Mean
Moderate	475	575	725	592	0·8	6·3	15·7	7·6	18·8	43·8	202·4	88·3
Steep	238	1,463	6,875	2,858	1·6	48·5	913·3	321·1	53·2	1,274·3	1,7075·0	6,134·1
Mean	356	1,019	3,800		1·2	27·4	464·5		36·0	659·0	8,638·7	

	Slope	Method of brushwood disposal	Interaction	Slope	Method of brushwood disposal	Interaction	Slope	Method of brushwood disposal	Interaction
Standard Error ..	324	337	476	62·6	64·2	90·9	651·1	597·4	844·9
Sig. diff. (P=0·05)	5,824	1,321	1,869	1,124·9	252·1	356·9	11,697·8	2,345·4	3,317·1
Sig. diff. (P=0·01)		2,192	3,099		418·0	591·9		3,889·7	5,501·1

TABLE III

Run-off and erosion data for all plots during the first two years of the experiment.

Period during which run-off occurred	Precipitation causing run-off: Amount mm.	Amount in.	No. of days	Area No.	Angle of slope	Run-off in gallons per acre: Brushpiles unburnt	Alternate brushpiles burnt	All brushpiles burnt	Litter-loss in pounds per acre: Brushpiles unburnt	Alternate brushpiles burnt	All brushpiles burnt	Soil-loss in pounds per acre: Brushpiles unburnt	Alternate brushpiles burnt	All brushpiles burnt
9.xii.52 to 22.i.53	436·5	17·19	19	1	4°15′	4,400	1,150	24,475	18·8	10·9	1,778·1	25·0	57·8	9,059·5
				2	5°45′–5°50′	—	13,975	26,750	—	373·4	2,406·2	—	3,175·0	14,260·4
				3	5°50′	7,025	6,625	24,900	48·5	51·6	3,025·0	329·7	446·9	16,714·0
				Mean		7,025	10,300	25,825	48·5	212·5	2,715·6	329·7	1,811·0	15,667·2
				4	13°55′–14°05′	11,875	30,000	69,700	984·4	2,068·8	3,353·1	4,115·7	19,314·3	102,501·7
				5	15°50′–16°00′	—	—	47,725	—	—	6,132·9	—	—	100,531·3
				Mean		11,875	30,000	58,713	984·4	2,068·8	4,743·0	4,115·7	19,314·3	101,516·5
26.viii.53 to 22.v.54	555·6	21·87	21	1	4°15′	2,200	1,100	1,150	Nil	Nil	Nil	Nil	Nil	Nil
				2	5°45′–5°50′	3,550	7,050	2,350	Nil	Nil	Nil	Nil	Nil	Nil
				3	5°50′	4,825	4,475	8,550	Nil	Nil	Nil	Nil	Nil	Nil
				Mean		4,188	5,763	5,450	Nil	Nil	Nil	Nil	Nil	Nil
				4	13°55′–14°05′	5,225	2,525	50,850	Nil	Nil	167·2	Nil	12·5	3,998·5
				5	15°50′–16°00′	4,425	13,275	25,275	Nil	25·0	67·2	Nil	242·1	698·4
				Mean		4,825	7,900	38,063	Nil	12·5	117·2	Nil	127·3	2,348·5

Run-off and Erosion in Relation to Site Factors.

A statistical comparison of run-off and erosion from plots on moderate and steep slopes, with three different methods of brushwood disposal, is presented in Table II. The figures are those from the first rain to cause run-off during this study and are tabulated separately because they enable comparisons of run-off and erosion to be made over all the plots. Similar comparisons are unfortunately not possible in respect of the first rainy season because of the flooding of three plots as mentioned above.

Table III contains results of run-off and erosion for the total period of study. No figures have been included for the flooded plots, but figures from plots comparable with these have been used for comparison with the means of pairs of plots which were not affected by the flooding. Figures are also included for the plots on a gentle slope in Area 1.

Effect of steepness of slope.

Since slopes were represented by main plots, of which there were only two in each block, differences due to slope could not be established with statistical significance. The *F* test, however, revealed a high degree of significance for interaction between slope and brushwood treatment, and differences between moderate and steep slopes, in run-off, litter-loss, and soil-loss from plots on which all the brushwood had been burnt were significant at the one per cent. level (Table II).

An examination of the figures in this table shows that erosion in all cases increased appreciably with increase in slope, as did run-off in both treatments involving burning of brushwood. In the unburnt plots, however, run-off was greater on moderate than on steep slopes. This anomalous result was due to the fact that run-off from the steep slope in Block I was abnormally low, and that from the moderate slope in Block II abnormally high, in relation to that from comparable plots.

A similar rising trend in the amount of run-off and erosion with increase in slope is shown by the available results for both rainy seasons in Table III. Text-fig. 2 also illustrates the effect of slope on soil erosion.

Effect of different methods of brushwood disposal.

During the first rain for which results were recorded, differences in run-off, litter-loss, and soil-loss between plots in which all the brushwood was burnt and those in which there was no burning or only partial burning of brushwood were highly significant (Table II). Though there was no significant difference in any of these factors between plots in which there was no burning and those in which alternate brushpiles were burnt, the rates of loss in the latter were considerably higher than in the former.

The increase in total run-off and erosion associated with removal of some or all of the brushwood by burning is shown in Table III to hold on all three degrees of slope and in both the first and second rainy seasons. The very considerable increase in the amount of soil eroded from plots in which all brushwood was burnt as compared with those in which some or all of the brushwood was preserved is clearly illustrated in Text-fig. 2.

Effect of litter.

The differences in rate of run-off and erosion associated with different methods of brushwood disposal were due in no small part to the effect of litter. When the plots were first laid out, there was a litter layer about one inch in thickness over the whole surface of all the plots. This layer was unbroken in the main, but the movement of logs during exploitation operations had occasionally disturbed it and exposed the mineral soil. When the burning of brushwood was carried out, however, the litter was destroyed on and near the sites of the burnt brushpiles in plots with partial burning and over most of the surface of the plots in which all brushwood was burnt.

In order to follow the progress of erosion, the surface of all plots was carefully examined after the first rain to cause run-off and also after a second high-intensity rain which occurred about a month later.

After the first rain, which had an average intensity of 44 mm. per hour, there was no disturbance of the plot surface, irrespective of slope or treatment, if the rate of run-off had been less than 600 gallons per acre per hour, but with greater rates up to 2,000 gallons per acre per hour, the uppermost litter or soil layer was moved downhill by sheet flow, leaving characteristic ripple-marking on the surface of the plot. Where rates exceeded 2,000 gallons per hour, rill formation began, usually at points where the litter-layer had been destroyed by burning or disturbed during the exploitation of timber. Once formed, the course of rill-channels seemed to be mainly determined by local micro-topography. They appeared to widen rapidly at first, without deepening appreciably, but having reached a width of about six inches, began to deepen more rapidly, while the rate of widening decreased.

After this rain, four of the unburnt plots were ripple-marked and on one of the four, a shallow rill-channel extending for about 15 feet was formed, but the litter on the plot with the gentlest slope was quite undisturbed. On the plots in which the upper of the two brushpiles had been burnt, ripple-marking was general and one or more shallow rill-channels had also formed, beginning in most cases on or just below the site of the burnt brushpile. The plots in which all the brushwood was burnt each had extensive ripple-marking and one or more rill-channels up to an inch in depth.

The erosive effect of the second rain, which had an average intensity of more than 60 mm. per hour, was much more pronounced. Rilling took place on all but one of the unburnt plots, but rill-channels were shallow and seldom more than 15 feet long. Hoed grass-tufts had occasionally been washed short distances and a little litter and soil had been trapped by the lower brushpile on the steeper slopes. On plots with partial burning, rilling occurred in all cases and channels were scoured to a depth of two inches on the steeper slopes, while litter and soil were trapped by the lower brushpiles on all plots. The burnt plots were heavily rilled, some of the channels on the steeper slopes being two feet wide and three inches deep, and loose grass-tufts were washed right off the plots on the steeper slopes. Rill-channels in almost all cases were scoured down to a hard subsurface layer, leaving pedestals of the looser surface soil between.

These observations showed that the litter layer normally found on the floor of a mature wattle stand, if undisturbed, will give a considerable measure of protection against erosion and will not become incised by rill-channels except under rains of very high intensity or on steeply sloping ground. If, in addition, brushwood is stacked at intervals on the contour and not burnt, the brushpiles will reduce the momentum of run-off and trap any litter or soil which may be eroded by rains of high intensity from the areas between them. Such brushpiles should be laid as close to one another as possible, having in mind the fact that piles must be well-packed and at least six feet high when freshly laid. Depending on the crown density of the previous crop, this limitation will usually cause brushpiles to be laid at distances ranging from 20 to 40 yards apart. If brushpiles are stacked at greater distances than 40 yards apart, there is a risk that they will not check the rate of run-off sufficiently to prevent its momentum increasing to the point where severe wash takes place towards the bottom of long slopes.

It is noteworthy that average soil losses over the first season were five times as great on plots in which the upper of two brushpiles 28 yards apart was burnt as on plots in which neither was burnt. The tendency to rilling caused by the destruction of the litter in the vicinity of the burnt pile is thought to be mainly responsible for this difference, because the removal of the upper brushpile actually increased the distance over which run-off water could travel before reaching the lower brushpile by only 8 yards, or 33⅓ per cent., as compared with the unburnt plots. Under plantation conditions, the burning of alternate piles at similar espacement would allow run-off water to gain momentum over a distance of 52 yards, assuming a width of 12 feet for the burnt piles, and resultant soil-losses in such cases would probably exceed those of the experiment.

During the first year after clear-felling, the amount of soil erosion from the plots in which all brushwood was burnt, and most of the litter consequently destroyed, ranged from 4 tons per acre on the gentlest slope to 45·8 tons per acre on one of the steepest slopes, with an average over the five different slopes of 21·7 tons per acre. By contrast, the greatest loss from any plot in which brushwood was not burnt was 1·9 tons per acre, a figure which might well have been lower had it been possible to stack the brushwood in its final position while it was still green.

Effect of ground-cover.

As mentioned above, there was a marked increase in weed-growth in all the plots at the beginning of the second rainy season. The effect of this dense ground-cover upon run-off and erosion during the second year of the experiment was threefold. Firstly, it increased interception, thereby reducing the percentage of rainfall reaching the soil and also incidentally reducing the force of impact of raindrops on the soil surface, so lessening the probability of soil movement. Secondly, tufts of grass and the stems of herbaceous weeds reduced the momentum of run-off and presented a physical barrier to the washing of litter or soil. Lastly, the drain on soil moisture resulting from the transpirational requirements of this additional vegetation would tend to increase retention storage opportunity of the soil, so reducing run-off and consequent erosion.

Measurements were made of the percentage ground-vegetation cover in all plots and these percentages are listed in Table IV. In all cases, the percentages were computed on the surface area of the plot which was not occupied by brushwood. There was thus a smaller area available for weed-growth in plots with no brushwood burnt than in plots with partial burning, and plots with all brushwood burnt had the largest available area. The figures in Table IV, therefore, are weighted in favour of the latter treatment, which actually had larger *numbers* of weeds per plot than either of the others, despite the relatively small differences in percentage cover.

TABLE IV

Percentage ground-vegetation cover in run-off plots.

Area	Brushpiles unburnt	Alternate brushpiles burnt	All brushpiles burnt
1	7·3	6·7	8·5
2	13·1	12·5	11·5
3	5·5	16·1	26·3
4	11·1	34·8	10·1
5	16·8	19·6	27·3
Means	10·8	17·9	16·7

The high mean percentage ground-cover in plots with alternate brushpiles burnt was obviously mainly due to the very dense weed-growth in one plot. In general, the weed-growth under this treatment was very little denser than that in unburnt plots.

The marked differences between Areas 4 and 5 in the amount of erosion from plots with partial and complete burning during the second year (Table III) can be readily explained by the differences in percentage ground-cover of these plots shown in Table IV. It is obvious that increasing density of ground-vegetation has resulted in corresponding decreases in run-off and erosion. These results are in line with those obtained by Marston (1952) who found that when a forest cover of aspen was cut and removed without disturbing the herbaceous ground-vegetation or litter, the run-off from the area increased slightly, but there was no measurable soil-loss. On a comparable site,

however, on which all vegetation and litter was removed by cutting and burning, there was approximately 60 times as much run-off as before denudation, and the soil-loss amounted to 230 cubic feet per acre. Anderson and Trobitz (1949) also showed that a decrease in cover density had an important effect in increasing peak run-off and erosion during major floods. Packer (1951), on the other hand, found that plant cover density had no significant effect on run-off or erosion, but considered that this might have been due to the presence on his experimental plots of a litter layer which in itself was adequate to control run-off and erosion.

The results for the second year (Table III) indicate that a moderate ground-cover is adequate to control erosion and to keep run-off at a low level on ground which is not steeply sloping. Complete control of erosion on steep slopes, however, has only been effected where ground-cover has been supplemented by contoured brushpiles at intervals of approximately 30 yards, and where no litter has been destroyed by burning.

Conclusions.

These experimental results show that in the summer-rainfall areas, where high intensity precipitations are common over a period of at least three months in the year, considerable erosion can take place from land on which stands of wattle have been felled during the previous summer, unless special measures are taken to protect the soil.

A high degree of protection against loss of litter and soil is effected by the stacking of brushwood on the contour, in piles at least 6 feet high and 12 feet wide, at intervals of 28 yards. Burning, even of alternate brushpiles, increases the risk of erosion, and burning of all brushwood leads to serious loss of soil on land which is at all steeply sloping.

It would appear that the greatest risk of erosion occurs in the first summer after clear-felling and regenerating a stand of wattles. Thereafter, it is probable that the risk of erosion becomes progressively less as the tree crop matures, until such time as it is again felled. Thus, when wattles are managed on rotations as short as seven years and the burning of all brushwood is practised as well, a rapid rate of site deterioration may be expected. When longer rotations are employed, and where plantations are not situated on steeply sloping land, erosion following burning is less obvious and is apt to be overlooked. Once rilling has occurred, however, there is a tendency for run-off water to follow these rill-channels, and erosion on such sites will tend to become progressively more severe with succeeding rotations as long as burning is practised.

Acknowledgement.

Acknowledgement is made to Messrs. The Natal Tanning Extract Company, Ltd., who kindly supplied the rainfall data from which the average distribution in Text-fig. 1 was computed.

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BLACK WATTLE TANNIN—ANALYTICAL PROBLEMS AND DIFFICULTIES*

By C. G. GORDON-GRAY

Introduction.

For many years, wattle growers have been asking for a suitable method of grading bark by chemical analysis, rather than by the present method of visual grading. The difficulty of grading bark by chemical analysis is due to :—

(*a*) the long and tedious method of sampling as defined by the Official International Method of bark analysis,

(*b*) the empirical nature of the analysis which does not give an absolute figure for the tannin percentage.

In 1950 the Technical Committee of the Wattle Extract Manufacturers' Association invited the Wattle Research Institute to collaborate in an investigation into the chemical analysis of wattle bark to determine the possiblity of grading bark by this means.

At the outset the Committee realized that it would have to devise a method capable of giving results free from large variations due to analysts in different laboratories. If, therefore, more accurate results than those of the International Method, which allows a variation of three per cent. in tannin content between analyses of the same sample carried out in different laboratories, were to be obtained, previously accepted variations in method would have to be eliminated or reduced.

The Analytical Method.

The percentage tannin in a sample of bark is based on the aqueous extraction of a definite weight of bark in a Procter or Koch extractor at controlled temperatures. Fifty ml. of the colloidal extract solution obtained is evaporated to dryness in a tared evaporating basin ; 100 ml. is shaken with 6·25 g. of hide powder to remove the tannin, and 50 ml. of the 'non-tan' solution obtained is evaporated to dryness. The remainder of the extract solution is filtered through a Berkefeld candle to remove the colloidal fraction and 50 ml. of the filtered solution is evaporated to dryness. The residues of total solids, total solubles, and 'non-tans' so obtained are dried in an air or vacuum oven for three hours, cooled in desiccators containing concentrated sulphuric acid or silica gel dried at 100°C, and weighed. From the difference between the total solubles and non-tan residue weights, the tannin content is calculated.

The Official International Method requires that analyses of a bark sample be done in duplicate and that the tannin content obtained by the two determinations agree within 0·6 per cent. As in many other analyses, good agreement is achieved provided the duplicates are carried out together on the same day, but extraordinary differences appear when the analyses are done on different days.

Problems and Difficulties of the Analytical Method.

If wattle bark is to be graded by analytical means, representative samples from any consignment must be easily obtainable. The problem of perfecting the analytical method therefore falls into two distinct parts :—

(*a*) the achievement of a simple but adequate sampling method ;

(*b*) the improvement of the analytical method.

As detection of weaknesses in any sampling method is dependent upon the analytical method, it was deemed advisable to shelve the former problem until the latter had been satisfactorily dealt with.

*Reprinted from *The South African Industrial Chemist*, 1954, **8**, 8, by kind permission of the South African Chemical Institute.

It must be realized that little is known about the constitution of black wattle tannin ; recent work by Roux[1] and White et al.[2] has shown it to be a far more complex polyphenolic substance than was originally thought. The number of phenols so far demonstrated by using Craig's counter current distribution method followed by two-way paper chromatography[2] is 27, but, as yet, little is known about the aggregation of these phenols into groups, or about the behaviour of the groups in combination as black wattle tannin. Consequently, in view of the complex nature of the tannin, of hide protein, and of their interaction, it will readily be appreciated that the causes of differences in tannin content obtained by analysis are not easily determined.

Factors in the analytical method which may give rise to differences in determinations of the tannin content of a bark sample may be listed as follows :—

(i) The equipment used ; (ii) residue weight value ; (iii) moisture content ; (iv) analytical sample ; (v) extraction process ; (vi) candle filtration ; (vii) non-tan value.

(i) *Equipment used in the analysis.* During the early part of the present investigations, co-operative work done by a number of laboratories revealed an alarming degree of unreliability in the equipment used, notably oven thermometers and variations of temperature on different shelves in the same oven. This led to a realization of the need for standardization of all equipment, both in individual laboratories and among laboratories. Such standardization involved the temperature calibration of each shelf within an oven against the external thermometer, the desiccator size and shape, the desiccant (silica gel heated at 150°C. for three hours[3]) and its location in the ordinary Scheibler type desiccator, and the balance weights.

(ii) *The residue weight values.* In order to avoid differences which might arise from the extraction process, it was decided to work with extract samples instead of bark samples. These extract samples were specially prepared, and sub-samples weighed out in weighing bottles with ground glass stoppers at the Wattle Research Institute before being sent to the laboratories undertaking the analyses. Identically made up solutions from these weighed samples showed variations as large as 10 milligrams in residue weight when 50 ml. portions containing 0·25 g. of extract were evaporated to dryness in the different laboratories.

The Official Method states that the heating of residues must be continued until constant weight is obtained. No mention is made of the course to be adopted if the residue weight shows increase instead of decrease, although in the moisture determination it is stated if the bark weight increases then the minimum weight must be accepted.

To investigate this variation in weight of residues from identical solutions, six 50 ml. portions of an extract were evaporated to dryness in tared basins on a waterbath and heated together on a shelf in an air oven. After $3\frac{1}{4}$ hours, one pair of basins was removed, cooled, weighed, and returned to the oven. After five hours a second pair, together with the first pair of basins, was removed, cooled and weighed, and returned to the oven. After eight hours, all six basins were weighed.

During the experiment the air humidity increased from a medium percentage at the beginning to one approaching saturation at the end. The results are shown in Table I :—

TABLE I

Humidity per cent.	Time of drying hours	Basin nos. and residue weight g.
circa 50	$3\frac{1}{4}$	No. 8 0·2646 No. 9 0·2647
„ 65	5	No. 2 0·2652 No. 7 0·2651
	$3\frac{1}{4}+1$	No. 8 0·2651 No. 9 0·2653
„ 95	8	No. 3 0·2665 No. 5 0·2667
	5+2	No. 2 0·2667 No. 7 0·2668
	$3\frac{1}{4}+1+2$	No. 8 0·2665 No. 9 0·2668

The above results show that the same residue weight is obtained when basins are removed from the oven at the same time, and although a general increase in weight does occur, this increase appears to be more definitely related to the air humidity than to the length of time of heating, since residues which were heated for total periods of $6\frac{1}{4}$ hours, 7 hours and 8 hours, all give the same weight at the final weighing.

A study of air moisture interference indicates that this occurs not only during the removal of the residues from the oven and at the balance, where it is known to take place, but during the time that the residues are in the air oven. (Results, using a vacuum oven, normally only slightly lower than air oven results, showed variation due to difficulty of expelling all moisture from the oven and to contamination after opening the oven door.)

A further experiment in which lids were replaced on one set of large weighing bottles inside the oven before opening the door, and on a second set after opening the oven door, showed little difference between the two. In each case, however, increasing and decreasing the humidity of the laboratory air caused the residue weights to rise and fall, thus indicating that air moisture interference occurred mainly during the time of heating. Results are given in Table II.

TABLE II

Relative humidity per cent.	Lids applied after oven door opened		Lids applied before oven door opened	
	Basin No.	Residue weight g.	Basin No.	Residue weight g.
80	21	0·2693	26	0·2700
	24	0·2707	27	0·2702
47	21	0·2676	26	0·2674
	24	0·2683	27	0·2674
80	21	0·2703	26	0·2696
	24	0·2711	27	0·2702
34	21	0·2664	26	0·2666
	24	0·2679	27	0·2669

It was now considered imperative that an absolute value of the residue weight be obtained before an accurate tannin content could be determined. Therefore, an oven which allowed dry air (dried over silica gel) to be blown through it, and which enabled lids to be fitted on to basins before opening the door, was constructed. Such an oven would prevent all moisture interference except at the balance.

The residue weights obtained by use of the new oven were lower than those from corresponding residues dried in an air oven, but, and this is the most important point, the difference between the total solubles and non-tans, i.e., the tannin content, was constant within narrow limits for both ovens, provided that the order of handling total solids, total solubles, and non-tans in each determination was maintained in the air oven, during removal from the oven, and during weighing.

It was further demonstrated (see Table III) that the tannin content determined by difference remained nearly constant when the residues were exposed to the atmosphere for a short period, but changed markedly with longer exposures to an atmosphere decreasing in humidity. (The relative humidity of the atmosphere, although approximately 90 per cent. at the start of the experiment, decreased to nearly 50 per cent. at the end.)

TABLE III

	Total solids		Total solubles		Non-tans		Tannin per cent.
	g.	Diff.	g.	Diff.	g.	Diff.	
Desiccated from water bath	0·2342		0·2284		0·0469		38·7
Oven dried	0·2334	— 8	0·2276	— 8	0·0462	— 7	38·8
Exposed to air for 35 min.	0·2508	+174	0·2435	+159	0·0594	+132	38·7
Exposed to air for 3 hr. 35 min.	0·2586	+ 78	0·2524	+ 89	0·0562	— 32	41·6
Exposed to air for 22 hr. 35 min.	0·2603	+ 17	0·2534	+ 10	0·0528	— 34	42·8
Reheated in oven for 1hr. 30 min.	0·2334		0·2274		0·0460		38·8

When the residues are exposed for a short period to an atmosphere of high humidity, the uptake of moisture by all the residues is approximately the same, provided the non-tans have not reached a state of equilibrium with the atmospheric moisture during the time of exposure. This initial uptake of moisture is a function of surface area, which is the same for all residues, rather than of weight, which has only a slight effect. With longer exposures, however, each residue reaches its own equilibrium with the atmosphere, which is determined by the weight of the residue and the degree of humidity of the air, and since the weight of the non-tan residue is small compared with that of the total solids and total solubles, the increase in weight at the point of equilibrium is very much less ; hence the tannin percentage determined by difference varies.

Since the observed tannin content remained the same provided the residues were subjected to the same conditions of drying, the possibility presented itself that if residues were desiccated directly from the water bath, cooled and weighed, the tannin content would be the same as that obtained from residues which had been heated in an air oven for the normal 3-hour period. The maximum difference (based on 414 comparisons) in tannin content between the two methods was found to be 0·3 per cent., and this difference, which was normally 0·1 or 0·2 per cent., was due to the greater loss in weight by the non-tan residue during heating in the oven. This loss in weight may be due to a decomposition of one or more of the non-tan components, or to a decrease in the air moisture in the oven when compared with that of the water bath, causing the equilibrium between non-tan residue and air moisture to fall. If this is the case, then it will become necessary to obtain an absolute value of the residue weight before the exact tannin content can be determined.

The residue weight, therefore, is never an absolute figure under normal conditions of heating, cooling, and weighing, hence the percentage values of the three components, total solids, total solubles, and non-tans, cannot be compared (Table IV) in duplicate analyses if these are done on different days, whether in the same or different laboratories, unless the atmospheric conditions are identical for both analyses. Percentage of tans, however, being a difference, remains much more nearly constant.

TABLE IV

Sample No.	41		42		46	
Date of analysis	20.ix.52	4.ii.53	20.ix.52	10.ii.53	20.ix.52	4.ii.53
Total solids per cent.	54·4	55·5	57·5	59·8	49·4	51·7
Total solubles per cent. ..	53·4	54·2	56·4	57·9	48·8	50·6
Non-tans per cent.	10·1	10·9	12·4	13·7	11·2	13·0
Tans per cent.	43·3	43·3	44·0	44·2	37·6	37·6

The Official Method demands that the temperature be maintained at 18°C. throughout the analysis, but under local conditions during the summer months this is an impossibility, unless vastly more elaborate equipment is employed. Temperature recordings have revealed increases of 7°C. during the filtration period and as much as 10°C. during the time that the non-tan solution was in the shaker. Fortunately, however, even a substantial departure from the prescribed temperature can have little effect on the residue weights obtained.

The difference in concentration in 50 ml. of extract solution due to a temperature variation of 10°C. between the limits 20°C. and 30°C. is of the order of 1 milligram, and since the tannin content is obtained by difference, a temperature variation of 10°C. would have a negligible effect.

The content of insolubles seldom exceeds 2·5 per cent. and is normally in the region of 1·5 per cent. and since it is obtained by cooling extract from 90°C., at which temperature the 'insoluble' portion is soluble, to approximately 20°C., the effect of a 10°C. variation in the region of 20°C. on the insolubles is small. (See Table V.)

TABLE V

Replicate No.	18°C.			35°C.		
	Solids g.	Solubles g.	Insolubles g.	Solids g.	Solubles g.	Insolubles g.
1	0·2384	0·2334	0·0050	0·2378	0·2327	0·0051
2	0·2395	0·2344	0·0051	0·2370	0·2331	0·0039
3	0·2385	0·2329	0·0056	0·2371	0·2329	0·0042
4	0·2392	0·2336	0·0056	0·2373	0·2328	0·0045
Average	0·2389	0·2336	0·0053	0·2373	0·2329	0·0044

The efficiency of tannin absorption by hide powder has been shown to be unaffected between the temperature limits 10°C. to 30°C. (See Table VI.)

Since temperature variations between 20°C. and 30°C. have only a very slight effect on the final tannin figure, it is preferable to cool the extract solution only to room temperature in order to maintain a constant throughout the analysis, instead of the rising temperature which invariably follows cooling to 18°C.

TABLE VI

	10°C. g.	20°C. g.	30°C. g.
Sample A	0·0658	0·0652	0·0645
	0·0675	0·0642	0·0646
	0·0646	0·0660	0·0644
	0·0664	0·0649	0·0653
Average	0·0661	0·0651	0·0647
Sample B	0·0571	0·0563	0·0568
	0·0582	0·0569	0·0565
	0·0564	0·0569	0·0575
	0·0573	0·0577	0·0577
Average	0·0573	0·0570	0·0571
Sample C	0·0527	0·0521	0·0517
	0·0519	0·0517	0·0522
	0·0520	0·0516	0·0530
	0·0511	0·0519	0·0523
Average	0·0519	0·0518	0·0523

(iii) *The moisture content of a sample of bark.* For comparative purposes it is necessary to report the tannin content of a bark on a moisture-free basis. This cannot be done by the Official Method, as air moisture contamination has not been considered. With the oven described above, the moisture content is accurately determined as the lids of the weighing bottles are put on before the oven door is opened and are not removed for weighing. It has been possible to show that the equilibrium between a sample of ground bark (approximately 200 grams) in a closed tin, and the air moisture is fairly stable within 0·1 per cent. or 0·2 per cent. from day to day.

(iv) *The analytical sample.* The analytical sample made up of aliquots of fibre and powder as stipulated by the Official Method, very definitely gives rise to errors, the magnitude of which is determined by the difference in tannin content of each component, as it is impossible to separate completely the powder from the fibre in a sieving operation. Greater concordance is obtained when the bark is pulverized completely.

(v) *The extraction process.* By recording temperatures in the conventional extractors every five minutes for a number of extractions, it was shown that there is little or no variation. By constructing an extraction apparatus similar to the Procter, but using flasks of different size, it was shown that any such variation has very little effect upon the results obtained, thus eliminating this factor as a possible source of variation.

(vi) *The candle filtration.* It might well be assumed that because candles filtered at different rates, their efficiency as a filtering medium would differ accordingly. By using two different sets of candles, the one set filtering 250 c.c of distilled water in approximately 7 minutes, the other in 20 minutes, it was shown (Table VII) that the candle effect was negligible. On the other hand, a comparison of weights obtained from different day analyses of the same bark shows marked variation in the insoluble content.

TABLE VII

Residue weights obtained from the same extract when filtered through slow and fast filtering candles.

(The figures are averages from a number of recordings.)

	Slow candle g.	Fast candle g.
Solution made up from extract sample	0·2702	0·2702
Extract solution from cold water extraction of bark ..	0·2928	0·2932
Solution from bark boiled in water..	0·2239	0·2241
Solution from Procter extraction	0·2340	0·2340

(vii) *The non-tan value.* By observing all the aforementioned precautions in the Official Method and analysing bark samples on different days, the variation in the non-tan value could be demonstrated by comparing the figures obtained in the two analyses. Since the residues of total solids, total solubles, and non-tans, were heated in the same oven at the same time, the residue weights of the three components should rise or fall together. For example, if on the first day the residue weight values of the total solids, total solubles, and non-tans, were 0·2600 g., 0·2546 g., and 0·0510 g., respectively and on the second day the residue weight of the total solids was 0·2630 g., then the weights of the other two should be approximately 0·2576 g. and 0·0540 g., respectively. By comparing a number of duplicate analyses done on different days, it was seen that the non-tan residue weight often showed a decrease where the total solids and solubles showed an increase and vice versa.

A thorough investigation into the preparation of the hide powder with special regard to temperature and different operators, showed that neither of these factors affected the non-tan value to any appreciable extent. Yet a definite day to day variation was obtained in the non-tans, when the hide powder was prepared by two different

operators on each of the two days, but no significant difference was obtained between operators on the same day. All attempts to locate the causes of variation in the non-tans have so far failed. The non-tan variation is small, but is sufficient to lift the agreement between duplicate analyses outside the 0·6 per cent. limit for tannin content.

With all the above modifications made, 93 barks were analysed in duplicate on different days, and in the case of 30 of these barks a three months interval existed between duplicates. Of the 93 barks, only 10 had to be re-analysed due to a difference in tannin content of more than 0·6 per cent. Of these 10, three analyses differed by 0·7 per cent., one by 0·8 per cent., two by 0·9 per cent., and four by 1·1 per cent.

Conclusion.

It appears possible that by adopting the following precautions :—

(i) Standardizing equipment ; (ii) pulverizing bark samples for analysis ; (iii) obtaining the absolute moisture content of bark samples ; (iv) handling residues in a definite order during heating and weighing; the variation in tannin content arising in analyses of the same sample done by different laboratories may be reduced to very much less than 3 per cent. More co-operative work, however, remains to be done to establish this speculation.

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NOTES ON INSECTS OBSERVED DURING THE PERIOD 1953-1954

By L. L. J. OSSOWSKI

An account is given of wattle insects observed during 1953–54 and of the damage done. Several insects not previously recorded as potential wattle pests are listed.

The number of some insects increased in the year under review, notably the wattle bagworm, some wattle chafers, and termites. Several other insect species so far not recorded as potential wattle pests, namely a lasiocampid, a long-horn beetle, and a borer, were observed to damage plantations over large areas. A decrease was noted in the population of some other lasiocampids, the wattle noctuid, jassids and capsids, and the citrus thrips.

I. ORDER : LEPIDOPTERA

Family : *Psychidae*

1. *Wattle Bagworm,* Acanthopsyche junodi *Heyl.*

The number of bagworms increased considerably during the year under review and over 132,000 acres are now infested. The main centres of infestation were in the Port Shepstone and Richmond districts, the central part of the Midlands of Natal, and Zululand. In these areas, over 15,000 acres were completely defoliated. In some parts of all but the last-named area, the eruptive stage was reached during 1953-54 and the abatement is expected to take place during the coming season. In Zululand, the peak will probably be reached not earlier than during 1955-57, and some 20,000 acres are likely to be defoliated in the coming year. The Karkloof area is practically free from bagworms except for two plantations some eight miles north-east of Howick, which are heavily infested and form danger points for that district. The infestation in some smaller wattle areas in the immediate vicinity of Howick is showing signs of building up rapidly. In plantations around Pietermaritzburg, the infestation is still in its initial stage, but will probably enter the first year of the prodromal stage during the coming season and some 600 acres may be partially defoliated. In the Hilton Road area, the eruption took place last year in two plantations and infestation has now died down. In other plantations, where the infestation was in the first year of the prodromal stage during the year under review, the eruption and complete defoliation of some 400 acres may take place in the coming season. In the Hlobane area near Vryheid, the bagworm infestation shows a very slight increase, while in the Kambula area, the infestation is building up and in some parts has already entered the first year of the prodromal stage. In other parts of that district, where the first year of the prodromal stage was reached in 1953–54 or even earlier, defoliation of larger areas may take place during the coming season. The larger part of the Transvaal and Swaziland wattle area seems to be free of bagworms except for some plantations near Piet Retief where the infestation is building up, but is still in the initial stage. In the Transkei, some 2,000 acres near Umtata are infested and were partially defoliated. The infestation there is in the prodromal stage.

Mortality due to *Isaria* was particularly high in plantations more than 4,000 feet above sea level, while mortality caused by *Entomophthora* was spread fairly evenly over all plantations. Bagworms killed by polyhedral wilt were found mainly on the top of trees, while those which succumbed to *Isaria* were nearly always on the lower branches. Dipterous and hymenopterous parasites, particularly in plantations with a moderate or heavy infestation, caused high mortality, which amounted in some blocks to well over 17 per cent. Spiders, especially *Araneus* and *Evophrys* species, also accounted for some mortality. Birds and rodents were active in destroying bagworms, especially in plantations in the Kambula and Scheepersnek districts, where in two plantations, a very large number of bagworms was eaten by rodents.

During the year under review, 48,506 bagworms were collected and examined to

assess the natural mortality and determine its causes. The following table gives some of the findings according to the months of examination.

Month	No. of			% Mortality due to								Empty bags	Total mortality
	plantations	trees	bagworms	isaria	entomophthora	polyhedral wilt	diptera	hymenoptera	spiders	birds and rodents	unknown agents		
March	3	16	5,055	1·2	13·5	3·7	2·0	3·2	0·1	0·2	0·1	4·3	28·3
April	2	11	2,679	5·2	40·5	4·0	2·4	3·4	0·2	0·2	0·07	6·0	62·0
May	3	25	8,382	1·1	30·2	5·0	4·0	13·0	0·5	0·7	0·2	4·0	58·7
June	10	65	18,840	4·7	34·8	6·6	1·3	6·2	0·5	1·0	0·03	3·6	58·7
July	7	41	4,242	10·1	41·1	6·6	0·9	3·1	0·4	4·9	0·07	10·0	77·2
August	4	68	9,308	6·9	31·7	8·1	1·0	5·2	0·2	0·2	0·7	7·1	61·1

2. *Lictor Bagworm*, Clania moddermanni (*Heyl.*).

This species is steadily infiltrating wattle plantations and increased greatly in the Otto's Bluff and Albert Falls areas.

Family : *Tineidae*

3. *Clear Spiral Bagworm*, Melasina tyrophanes *Meyr.*

Plantations in the Karkloof district, especially those with dense undergrowth, carried a fairly large population of this bagworm species. No damage, however, was observed.

Family : *Lasiocampidae*

4. *Small Wattle Lappet Moth*, Anadiasia punctifascia *Wlk.*

Damage done by this pest decreased in plantations near the coastal belt except around Umzinto, where some 120 acres were partially defoliated. In the New Hanover and Fawnleas areas, approximately 500 acres of younger trees were completely defoliated. Larvae were also abundant in the Kambula district.

5. *Grey Wattle Lappet Moth*, Pachypasa truncata *Wlk.*

The population of this lasiocampid seems to have decreased and no serious outbreaks were reported. Large numbers of pupae were, however, observed in the Kambula district, but since wattles in that area were defoliated by bagworms, it may be that damage done by larvae of this lappet moth has been attributed to bagworms and reported as such.

6. *Large Wattle Lappet Moth*, Gonometa postica *Wlk.*

Larvae of this moth were abundant in the Table Mountain area and also around Vryheid, where some 75 acres of three-year old wattles were partially defoliated.

7. Mesocelis montana *Cram.*

This lasiocampid has not until recently been known to damage wattle trees, its food being confined to indigenous shrub species. In 1950, however, it was reported to have caused slight damage to wattle plantations at Ibeka in the Transkei. In 1953–54, the infestation spread and some 300 acres were attacked, of which over 200 were partially defoliated.

There is one generation in one year. The fully-grown larvae are brown with a yellow head and yellow patches along the sides of the thorax. The dorsum is covered with

long brown hairs and also bristly ones, and the sides with shorter hairs. The bristles cause severe irritation to the human skin. Pupation takes place in large, oval, parchment-like cocoons, covered with bristles, which can be found under stones and in the crevices of thick bark on the lower parts of older trees.

Family : *Saturniidae*

8. *Wattle Emperor Moth,* Gynanisa maja (*Klug*).

Larvae were abundant in Pondoland where around Lusikisiki, some 20 acres of three-year old wattles were defoliated.

9. *Willow Tree Emperor Moth,* Gonimbrasia tyrrhea *Cram.*

Damage done by this insect in the Transkei was less severe in 1953–54 and only 60 acres were completely defoliated at Cofimvaba, while there was no noticeable damage at Ibeka.

Family : *Noctuidae*

10. *Wattle Noctuid,* Achaea lienardi *Boisd.*

The wattle noctuid population seems to have decreased and only scattered, light infestations were reported from the Harburg area. A wasp, *Philanthus loefflingi* Dahlb. (*Sphegidae*), was found to be preying on noctuid larvae of all instars.

11. *Army Worm,* Laphygma exempta *Walk.*

The army worm, which is reputed to feed only on plants belonging to the grass family, attacked newly-germinated wattle seedlings intercropped with maize, in the Seven Oaks district. The worms fed first on grass, then attacked the maize, and finally the wattle seedlings. Approximately 25 acres of wattle were damaged. The army worm was also reported to have attacked turnip fields in the Karkloof area.

II. ORDER : COLEOPTERA

Family : *Melolonthidae**

12. *Large Wattle Chafer,* Hypopholis sommeri *Burm.*

These beetles were widespread throughout the southern part of the wattle belt and also in the Midlands of Natal ; their population seems to be steadily increasing. Nearly 4,000 acres of wattles up to three years old were damaged, the outbreak being particularly severe in Pondoland and the Port Shepstone district, where some 300 acres were partially defoliated. The infestation around Harding and Ixopo and in the Umvoti and Kranskop districts was also fairly severe. In the Umvoti and Kranskop districts, nearly 100 acres were completely, and over 1,500 acres partially, defoliated.

Around New Hanover, Lion's River, and Pietermaritzburg, patches of wattle were partially defoliated, but these were mainly on the edges of plantations.

13. *Small Wattle Chafer,* Monochelus calcaratus *Burm.*

This insect is well established in plantations in the southern part of the wattle belt and in the Midlands of Natal. Outbreaks were reported from the Bizana, Harding, Richmond, and Ixopo districts, where of over 500 acres attacked, approximately 30 acres were completely, and 350 acres partially, defoliated. In plantations around Greytown, some 250 acres were partially defoliated, while in the Lion's River area,

*Classification changed from *Scarabaeidae* following advice (*in lit.*) from the Commonwealth Institute of Entomology, British Museum (Natural History), London.

nearly 150 acres were infested, 50 acres being completely defoliated. Usually the trees attacked were between two and three years old.

14. *Mashonaland Chafer*, Eulepida mashona *Arrow*.

The damage done by this pest to wattle plantations in Southern Rhodesia has very much decreased, due to the extensive spraying and fogging operations conducted during the last three seasons and to the use of soil insecticides in all endangered newly-established plantations.

Family : *Chrysomelidae*

15. *Iridescent Wattle Chrysomelid*, Colasposoma fulgidum *Lef.*

The number of this insect seems to be increasing and damage observed was serious in very young plantations near Greytown and Pietermaritzburg, where 30 acres were completely, and 50 partially, defoliated.

Family : *Cerambycidae*

16. *Red-banded Longhorn Beetle*, Pycnopsis brachyptera *Thoms.*

This species appears to have become fairly common and damage in young plantations up to 18 feet high is serious. Thin branches are usually ring-barked, tops are broken by wind, and crowns become deformed.

The damage was particularly severe in the Table Mountain area, also around Umzimkulu and near Barberton.

Family : *Lamiidae*

17. *Longhorn Wattle Borer*, Eunidea strigata *Fhs.*

The wattle borer attacks moribund trees mainly on the edges of plantations. Newly-felled wattles quickly become attractive and it has been observed that eggs are laid on such trees one or two days after felling. The use of trap trees, which should be de-barked after the eggs of the borer have developed into larvae, would help in checking the spread of these insects.

Some 100 acres of younger wattles in the Wartburg district were attacked and damaged.

Family : *Bostrychidae*

18. Sinoxylon ruficorne *Fhs.*

This species has lately caused considerable damage in younger wattle plantations near Wartburg, the attack coinciding with that of the longhorn wattle borer. The adults bore mainly into the green parts of the leading shoots, making axial tunnels. Often the leaders are killed or, if girdled, broken by wind. In the drier parts of the wattle growing areas, these beetles bore into thicker stems, and since the tunnels run radially through the bark and outer sapwood, the trees are easily broken by wind.

III. ORDER : ISOPTERA

Family : *Termitidae*

19. Microtermes *spp.*

Termites of these species were responsible for damaging young wattles over an area of 300 acres on the southern border of Zululand and some 20 acres near Umzinto. Plantations which had been re-established after being destroyed were damaged again. It was

observed that the termites attacked only the tap roots, eating the cortex and part of the lower-lying layers. In consequence, tap roots died and trees fell over after the first strong gusts of wind. So far, lateral roots have not been attacked. Large numbers of pugnacious ants, *Anoplolepis custodiens*, Sm., which prey on termites, were found in the plantations in question.

Family : *Hodotermitidae*

20. *Harvester Termite*, Hodotermes mossambicus (*Hagen*).

Harvester termites invaded wattle country near Kranskop, destroying newly-established wattle plantations over a considerable area. In the main, it was trees growing on northerly and north-westerly slopes which were attacked.

IV. ORDER : HEMIPTERA

Families : *Jassidae* (*Cicadellidae*) *and Capsidae*

21. *Large Green Jassid*, Bythoscopus cedaranus *Naudé*, and

22. *Brown Capsid*, Lygidolon laevigatum *Reut.*

The attack was less severe in 1953–54, probably due to the cold and wet weather. The outbreaks, which usually occur during November/December, were delayed until March/April in some parts of the country.

Some 5,000 acres were reported to be attacked and defoliated, mainly in the Pinetown and Richmond districts, where about 1,500 acres were damaged. In the Harding, Piet Retief, Paulpietersburg, New Hanover, and Kranskop areas, the damage was less severe and spread over 100–200 acres in each district.

V. ORDER : THYSANOPTERA

Family : *Thripidae*

23. *Citrus Thrips*, Scirtothrips aurantii *Faure.*

There was less evidence of this pest and no damage was observed during this season. Heavy rains in the early summer probably hindered the normal development of the thrips.

Acknowledgements

Acknowledgement is made to those wattle growers who have furnished information and records of wattle insect pests and to Dr. H. K. Munro, Collection Entomologist, Pretoria, for suggestions in the selection of common English names of insects listed under 8, 9, and 12 to 14.

AN AERIAL SPRAYING EXPERIMENT AGAINST WATTLE BAGWORM
(*Acanthopsyche junodi* HEYL.)

By L. L. J. OSSOWSKI

Replicated sample plots were sprayed from the air with 0·75 lb. Toxaphene per gallon of Diesoline at two different rates, viz., three and four gallons per acre, to test the effect of this insecticide on the wattle bagworm (*Acanthopsyche junodi* Heyl.) and other wattle fauna. To facilitate collection and minimize loss, sheets were placed under the sample trees and all the invertebrates which fell on to them were collected for identification at intervals after spraying. The mortality of bagworms was assessed after seven to thirteen days. The difference between the mortality of bagworms from the upper and from the lower parts of the trees and the percentage kill in relation to density of population were investigated. The rate of the " fall-off " of dead and moribund bagworms was also examined.

The difference in mortality between the three and four gallon per acre treatments was not statistically significant, but in each case the kill was greater in the upper than in the lower parts of the trees. Provided a good cover was obtained, a high kill resulted where the bagworm infestation was light, and even where the plantation had a dense canopy, fairly good results were obtained. Where, however, the population was very high, results were poor.

Large numbers of invertebrates other than bagworms were killed during spraying. The species collected are listed in natural orders separately for each sampling period and are also classified into groups as beneficial, indifferent, and harmful.

Laboratory tests and small-scale field trials on spraying mainly from the ground have shown that Toxaphene dissolved in Diesoline is toxic to bagworms in their earlier larval stages. When, however, on the basis of this experience, some 4,000 acres of wattle plantations were sprayed from the air in 1952, the results were variable and, in some cases, contradictory. In order to obtain the critical evidence so far lacking in respect of aerial spraying, a replicated experiment was carried out at Windy Hill on the 11th November, 1953, to test the effect on bagworms up to the third instar and on other wattle fauna of Toxaphene in Diesoline sprayed from the air at two different rates.

Experimental Method.

(i) *Plot lay-out and description.* A randomized block arrangement comprising six replications of each treatment was used, each block consisting of 3 plots, each of approximately five acres (572 yd. × 42 yd.), making a total of 18 plots. The corners of the plots to be sprayed were demarcated with coloured flags, a different colour being used for each treatment, while the corner trees of the control plots were marked with three rings painted on the trees at breast height. At each end of the plots to be sprayed, a smaller flag was placed half-way between, but somewhat lower than, the corner flags. This was done to indicate to the pilot the two swaths into which each plot was divided for spraying.

The plantations in which the plots were laid out were established between 1945 and 1948 and carried 450 to 500 trees to the acre. The canopy was fairly even. The average height of the trees was 47 ft. and that of the crowns slightly more than 24 ft., with an average area at the base of 72 sq. ft. Taking into consideration the various types of crowns in the plots (Classes 1 and 2, *a* to *d*, according to the classification adopted by the British Forestry Commission), the crown volume averaged approximately 600 cu. ft.

(ii) *Selection of sample trees, and method of sampling.* One week before spraying, five sample trees were selected in each plot, marked, and numbered. These were taken from an inner area of 500 yd. × 40 yd., since it was observed in 1952 that the edges of the plots are often unevenly covered by insecticides.

On the day preceding the spraying operations, sheets were placed under the sample trees to make it possible to count the " fall-off " of bagworms occurring in the interval

between spraying and sampling and also to collect invertebrates other than bagworms which might have been killed by the spray. The sheets were examined 24 hours after treatment of the plots, then three and six days later, and finally on the day of felling the sample trees for collecting bagworms, i.e., between the seventh and thirteenth days after spraying. Bagworms which had fallen off were counted and recorded and all other dead specimens found on the sheets were collected for identification.

Before felling a sample tree, large sheets were spread under it and where it would fall, to catch all bagworms dislodged by the felling operations. Measurements were taken of the total height of the tree and of the height and basal diameter or circumference of the crown. The crown was divided into upper and lower portions of equal length and all bagworms stripped from each part separately for immediate examination in the field laboratory. The worms were slowly exposed to gentle heat to stimulate movement, but those which did not move were counted as dead only after confirmation by dissection ; during moulting periods, bagworms remain outwardly fairly motionless, even on exposure to heat. At the time of examination, 65 per cent. of the bagworms were in their third instar, 27 per cent. in the second, and 8 per cent. in the first.

(iii) *Insecticide and method of application.* The insecticide used was 0·75 lb. Toxaphene per gallon of Diesoline, applied at two different rates, viz., six plots were sprayed with three gallons and six with four gallons per acre while six were left unsprayed. Thus the actual amount of Toxaphene was two and a quarter and three pounds per acre respectively in the sprayed plots.

The aircraft used was a 135 H.P. Piper Super Cub PA–18–A equipped with 24 type D10 spray nozzles and with a tank holding 45 gallons of insecticide. The plane, flying at 80 m.p.h., used a pressure of 65 lb./sq. in. to apply three gallons per acre, and 85 lb. when discharging four gallons.

To avoid mistakes in the sequence of spraying plots, hydrogen-filled, captive balloons of approximately 40 inches diameter were placed on the approach side of the plot immediately before spraying, the colour of the balloon indicating the rate of application for the plot. These balloons were secured some five to ten feet above the central white flag marking the swath, and as soon as the plane had passed, were hauled down and placed over the next plot to be sprayed.

To spray one plot, the plane had to make two runs, each covering a width of approximately 20 yards. Six flights were made, each spraying two plots. The plane started for the first pair of plots at 5.15 a.m. and took off for the last flight at 6.45 a.m. The temperature at 5.15 a.m. was 61°F. and rose to 65°F. by 6.54 a.m. ; the relative humidity throughout the application was approximately 94 per cent. The sky was overcast and there was no wind during operations, except when spraying the second half of the second plot in the last flight, when a slight wind (velocity approximately two m.p.h.) rose. The pilot, however, having noticed this, allowed for drift and obtained a good cover for this plot. All plots were covered very well with insecticide except that receiving three gallons in the fourth application, where approximately one yard along the whole eastern border of the plot was missed. Fortunately this strip lay outside the area marked for sampling.

A total of 1·64 inches of rain fell during the period of sampling on the following days :

3rd day after spraying	0·71 in.
4th day after spraying	0·22 in.
5th day after spraying	0·16 in.
6th day after spraying	0·36 in.
9th day after spraying	0·04 in.
11th day after spraying	0·15 in.

The wind velocity during that period never exceeded four to seven m.p.h., and was usually lower at night than during the day.

Results.

The extreme range of corrected kills (means of five sample trees) in the twelve treated plots was from 56·3 per cent. to 91·7 per cent., but the mean percentage kill (Table I) was not significantly different at the two levels of application.

TABLE I

Mortality of bagworms 7 to 13 days after treatment.

Treatment	Total mortality %		Corrected kill %	
	Range of means in 6 replicates	Mean of 6 replicates	Range of means in 6 replicates	Mean of 6 replicates
Unsprayed control	16·0—30·1	24·0	—	—
3 gall./acre	56·5—92·7	76·1	56·3—91·7	71·7
4 gall./acre	60·9—91·3	77·8	58·9—86·8	74·7

In the lower parts of the crowns, however, the mean kill was significantly less (P=0·05) than in the upper parts by 14·6 per cent. for the three gallons per acre and 19·2 per cent. for the four gallons per acre treatment (Table II).

TABLE II

Mortality (excluding "fall-offs") in the upper and lower parts of crowns.

Treatment	Upper portion		Lower portion	
	Range of means in 6 replicates	Mean of 6 replicates	Range of means in 6 replicates	Mean of 6 replicates
Unsprayed control	13·9—28·3	22·3	11·5—28·5	26·0
3 gall./acre	57·7—96·9	79·8	46·3—81·0	65·2
4 gall./acre	71·9—88·1	80·1	23·4—81·8	60·9

The penetration of the insecticide into the lower parts of the crowns appears to have been insufficient to ensure high mortality. This is readily understood when it is realized that the crowns in one acre of trees occupy a volume of approximately 300,000 cu. ft. and have a surface area which amounts to over 230,000 sq. ft., or over five acres.

In earlier work, there had been indications that in plantations with a very high bagworm population, the kill was low in spite of an even cover obtained. To check the kill in relation to density of population, the percentage kill on individual sample trees was grouped into five classes (Table III) and compared with the average number of bagworms per tree. From this comparison, it was clear that the fewer bagworms there were per tree, the higher was the kill.

TABLE III

Kill in relation to density of population.

	Corrected kill %				
	100	95—99·9	90—94·9	70—89·9	Below 70
No. of sample trees (out of total of 60)	4	6	11	25	14
Average no. of bags per tree	90	111	561	738	1,763

Bagworms tend to gather in the higher parts of wattles, but if a tree is overcrowded, a certain proportion spreads over the lower parts of the crown. Further, a very high bagworm population is in itself an even more effective barrier against penetration than is a close canopy. In wattles with a dense crown and a low bagworm population, the kill was higher than in trees with a thin crown and a high population. Thirty-five sample trees with an average crown volume of approximately 700 cu. ft. and a population of approximately 400 bagworms per tree showed a higher percentage kill than twenty-five trees with an average crown of approximately 460 cu. ft. and a population of approximately 1,400 bagworms per tree.

From a vantage point which revealed the extent of defoliation, coloured photographs of all plots in three replications were taken, about three months after treatment, to record the effect of spraying and the difference between treatments. The variation in bagworm population within the plots before spraying was known to follow a similar pattern in both treated and untreated plots. The untreated plots, which were partially or completely defoliated, showed up in varying shades of brown on the photographs, depending on the extent of the defoliation. In treated plots which, prior to spraying, were lightly or moderately infested and where the kill was high, the wattles were green, but centres of infestation with a heavy bagworm population and a low kill appeared brown on the photographs.

TABLE IV

Mean percentage "fall-off" per tree at intervals after spraying.

Treatment	24 hours	3 days	6 days	7–13 days	Total
Unsprayed control	0·04	0·12	0·13	0·12	0·41
3 gall./acre	1·85	2·36	1·88	0·02	6·09
4 gall./acre	1·93	2·65	1·50	0·03	6·11

The " fall-off " of dead and moribund bagworms (Table IV) depends largely on weather conditions, rain and high winds following spraying tending to increase it. Thirteen days after spraying, it amounted to slightly over 6 per cent. in the treated and 0·41 per cent. in the control plots. While the " fall-off " in the controls did not vary much from day to day (average approximately 0·03 per cent.), it was highest in the treated plots three days after spraying and fell well below normal between the seventh and thirteenth days. The third day after spraying had the heaviest rainfall during the sampling period.

TABLE V

Natural orders of invertebrates (other than bagworms) found on sheets after spraying.

	Time of collection after spraying	Orthoptera	Psocoptera	Hemiptera	Lepidoptera	Coleoptera	Hymenoptera	Diptera	Araneae	Total
Unsprayed control (30 sheets)	24 hours	0	0	0	0	1	2	0	0	3
	3 days	0	0	2	1	0	0	0	0	3
	6 days	0	0	0	0	1	0	0	0	1
	7–13 days	0	0	1	0	0	0	0	0	1
	Total	0	0	3	1	2	2	0	0	8
Sprayed (60 sheets)	24 hours	0	1	0	24	20	103	18	5	171
	3 days	0	0	2	13	2	5	2	0	24
	6 days	3	0	27	31	0	28	4	1	94
	7–13 days	3	0	0	0	0	0	0	0	3
	Total	6	1	29	68	22	136	24	6	292

Many invertebrates other than bagworms were found on the collecting sheets, apparently killed by the insecticide, and are listed in natural orders in Table V. It can reasonably be assumed that the number of *Psocoptera*, *Hymenoptera*, and *Araneae* is an underestimate, since it was impossible to find every specimen of these minute invertebrates hidden in the wattle flowers which had fallen in profusion on the sheets after rain.

While on 30 sheets covering 45 sq. yd. in control plots, only eight specimens were collected, the number found on 60 sheets covering 90 sq. yd. in the sprayed plots was 292. Of these latter, at least 179, equivalent to nearly 10,000 per acre were definitely beneficial to wattle plantations (Table VI).

TABLE VI

Economic importance of invertebrates found on sheets.

Treatment	Beneficial	Indifferent	Harmful	Total
Unsprayed control	2	0	6	8
3 and 4 gall./acre	179	15	98	292

The largest number of beneficial insects belonged to the hymenopterous families *Chalcididae*, *Eulophidae*, *Apidae*, and *Ichneumonidae*. The beneficial *Diptera* were represented mainly by the *Tachinidae*, and the *Hemiptera* by sucking bugs of the family *Pentatomidae*. Some arachnids also, belonging to the families *Argyopidae*, *Thomisidae*, and *Lycosidae*, were found. The harmful insects collected were mainly lepidopterous larvae of the families *Lasiocampidae*, *Saturniidae* and *Noctuidae*, and adult *Coleoptera*, chiefly the *Melolonthidae* and *Chrysomelidae*. Specimens classified as indifferent were mainly *Diptera* of the families *Sciaridae*, *Bibionidae*, *Trypetidae*, and *Otitidae*. Representatives of the *Asilidae* were also counted as indifferent, though they may be either beneficial or harmful, depending on the insect life in the various plantations.

Adults which were on the wing during spraying were found on the sheets within 24 hours, whereas those which rarely use their wings, such as some sucking bugs, fell on to the sheets after six days. Immature specimens of *Locusta elegans* (Thunb.) were found on the sheets six to thirteen days after treatment. A complete list and analysis of the fauna found after spraying will be published elsewhere.

Since nearly all the beneficial invertebrates found on the sheets in treated plots are polyphagous, i.e., have more than one host or prey on more than one insect species, their reduction by spraying could adversely affect the natural control of some secondary, or so far unknown, wattle insects and so allow a new pest to arise. The observed mortality of beneficial insects suggests that this aspect of the problem must not be neglected.

The experiment has demonstrated the possibility of achieving in favourable circumstances a high degree of control of the wattle bagworm by aerial spraying. It has, however, revealed certain factors, notably high density of insect population and inadequate penetration of the canopy, which militate against success. This has, in part, suggested the policy of concentrating commercial spraying upon lighter infestations of bagworm in younger and, therefore, less heavily canopied trees. Biological considerations not discussed here support this policy and it was consequently made the basis of the 1954 commercial spraying campaign.

Acknowledgements.

Acknowledgement is made to Mr. John Gibson, Windy Hill and his field staff for untiring assistance during the organization and execution of the experiment, to Dr. A. A. Rayner, Professor of Biometry in the University of Natal, for advice on sampling methods and assistance in the analysis of data, and to Mr. P. Bagshawe of Union Crop Sprayers (Pty.), Ltd., Pretoria, for the very skilful spraying of the experimental plots.

GROWERS' BULLETINS

THE CONTROL OF BRAMBLE BY CHEMICAL WEED-KILLERS

By H. SHAW

Since 1949, a series of experiments has been in progress to find the best chemical means of controlling various weeds prevalent in the wattle areas of Natal. Of these, the trials on the control of bramble, though not yet quite complete, have reached a stage at which a recommendation can be made with a fair degree of confidence. A brief summary of these results and the consequent recommendations is, therefore, presented now in anticipation of the detailed account of the experiments which will be published elsewhere in due course.

The earlier experiments showed that of the hormone weed-killers in commercial use, only 2:4:5-trichlorophenoxyacetic acid (2:4:5-T) was of appreciable value against bramble. In particular, it was clear that 2:4-dichlorophenoxyacetic acid (2:4-D) was virtually useless for this purpose. These experiments also demonstrated the superiority of the amine salts and esters of 2:4:5-T over the sodium salt.

In the next stage of the investigation, every ester of 2:4:5-T commercially available and two specially compounded amine salt preparations were tested. Only minor differences, of doubtful significance, were found between these various products.

On the other hand, there were marked differences between replicates in any one treatment, but these could usually be explained by the growth of the bramble in each plot. In general, the best results were obtained on the most mature and vigorous growth. This is almost certainly due to the greater surface area of cane presented, since in the case of bramble, thorough wetting of the stems rather than of the leaves is important.

On the basis of these experiments, supported by observations made in the course of commercial spraying operations, the following recommendations for the treatment of bramble are made. Complete success cannot be guaranteed and further work will doubtless bring improvements, but if the detailed instructions are closely followed, a very fair measure of control can reasonably be expected.

An ester preparation of 2:4:5-T must be used (the amine salts are not commercially available) at a concentration equivalent to about one pound of acid per acre. To calculate the amount of the preparation necessary to give this, the manufacturer's declaration of acid content, as stated on the container, must be used. For example, one product on the market contains 3·6 lb. acid per gallon and would be used at two pints (equivalent to 0·9 lb. acid) per acre ; another product contains 2 lb. acid per gallon and would be used at four pints per acre. It should be noted that the manufacturer's instructions for use sometimes indicate unnecessarily high concentrations. Preparations containing mixtures of 2:4-D and 2:4:5-T are on the market and one of these has been recommended for bramble control. Such preparations should not, however, be used for this purpose as, although cheaper per gallon than 2:4:5-T preparations, they are much dearer per unit of 2:4:5-T, the only constituent effective against bramble.

The appropriate amount of weed-killer for one acre should be made up to 100 gallons with water. If, however, the spraying equipment available makes it difficult to cover the area thoroughly with this amount, it may be increased to 150 or even 200 gallons, so long as the correct equivalent of acid per acre is used.

The cane should NEVER be cut before spraying. Contrary to a commonly held view, young regrowth is more resistant than old cane, and the best results come from treating mature brambles. For the same reason, spraying in late summer or early autumn is desirable. Particular attention must be paid to wetting the stems as thoroughly as possible—the leaves do not matter so much. Consequently, a driving spray is preferable to a mist.

In the experiments, several types of hand-operated equipment were used for spraying, but these would not be practicable for large-scale operations. For commercial spraying, a Bean fire pump has been found very suitable, and any similar machine capable of giving the required output would be appropriate.

Usually there is little visible sign of the effect of the spray within the first week or so after spraying. Experience over several years suggests that the slower the appearance of damage, the better the results are likely to be. For this reason, the use of these herbicides in oil solution is not recommended against bramble, since the rapid damage to the plant tissues which occurs inhibits absorption of the hormone and so militates against good results. The full effect of the spray cannot be judged until well into the summer following treatment, and even this may not represent quite the final position.

Largely because of the difficulty of adequately wetting all the stems, a small amount of regrowth will usually occur. This should NOT be treated immediately it appears, but should be allowed to mature thoroughly before being resprayed.

The total cost of spraying cannot be closely estimated since the cost of application may vary widely according to the type of equipment used and the quality of the labour available. The approximate cost of the material, however, will be from 25/- to 35/- per acre according to the particular product used and the quantity purchased. These costs refer, of course, to a hypothetical acre of solid bramble. The weed will much more commonly be encountered in patches or rows, but the above figures should enable an estimate of the cost to be made.

A NOTE ON THE USE OF INSECTICIDAL FOGS AGAINST THE POWDERPOST BEETLE, *Lyctus brunneus* (STEPH.)

By L. L. J. OSSOWSKI

The powder-post beetle, *Lyctus brunneus* (Steph.), causes considerable damage to the sapwood of seasoned timber and in some instances also to timber in the process of drying. In May, 1952, a replicated experiment was started to determine whether an insecticidal fog of the type used against the wattle bagworm was effective against lyctus beetles in timber stacks, but owing to the lack of sufficient material for examination, the results were inconclusive.

In May, 1953, a second replicated experiment was planned using twelve stacks of *Eucalyptus saligna* boards which were infested with the beetle. The volume of each stack was approximately 100 cu. ft. and the boards were 1 to 1½ inches in thickness. Shortly before treatment, three planks were taken for sampling, one from the top, one from the middle, and one from the bottom of each pile, and on each were marked three squares each four by four inches.

Treatment was started in June, when the insects were in their pupal or larval stages. Three stacks were treated with five per cent. DDT, three with two per cent. gamma-BHC, and three with one per cent. Dieldrin, while three were left untreated. The insecticide was dissolved in Diesoline and applied at the rate of four pints to each treated stack by means of a "Swingfog" insecticidal fog generator. The piles were covered with a tarpaulin during fogging operations, which occupied ten to twleve minutes per stack. Five months later, the squares marked on the boards selected for sampling were examined and the number of living and dead larvae, pupae, or adults counted in each square. It was found that in the planks treated with DDT and BHC, all larvae and 65 per cent. of the pupae were dead, while the remainder of the pupae, and all adults which were inside the wood, awaiting favourable weather conditions before emerging, appeared to be healthy. In stacks treated with Dieldrin, the mortality of larvae was 35·6 per cent., against 33·5 in the untreated control piles, while all pupae and adults appeared to be healthy. The treated stacks were left in the open and were re-infested during the summer, probably from timber in the adjacent yard.

A further experiment was conducted in November, when the insects were on the wing. A set of uninfested stacks of *E. saligna* boards, somewhat smaller in volume than those used in the previous experiment, was fogged. The rate and method of application of the insecticide and the method of assessment of mortality were as before. If was found that stacks treated with DDT and BHC were protected against attack for six to eight weeks and that there was no significant difference between the two treatments. Application of Dieldrin gave inferior results, protecting the boards for ten days only. The control stacks became heavily infested some two to five days after the start of the experiment.

From these exploratory experiments, it would seem that treatment with DDT and BHC against lyctus beetles shows promise and it appears that it would be worth while for those interested in the protection of harvested timber to carry out experiments on similar lines. For the benefit of anyone who may use this type of fog generator for such experiments, it should be mentioned that the oil vapour may sometimes catch fire when the outlet of the machine is placed in a small space lacking free ventilation. This happened during the experiment and one pile was set on fire by the fog generator. It should be possible, however, to overcome this shortcoming by using an adaptor sleeve with a fan and an extension pipe to direct the fog under the tarpaulin.

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Printed by THE NATAL WITNESS (PTY) LTD. *at Pietermaritzburg.*